Teachers' Seminar on Pharmacognosy and Related Subjects

Held under the Auspices of

The American Association of Colleges of Pharmacy

AN AMERICAN FOUNDATION FOR PHARMACEUTICAL EDUCATION
SUPPORTED EVENT

University of Utah College of Pharmacy
Salt Lake City
August 10 to 14, 1953

COMMITTEE

L. David Hiner, Chairman
H. W. Youngken, Jr.
T. C. Daniels
E. P. Claus
J. B. Burt
L. C. Zopf

TEACHERS' SEMINAR ON PHARMACOGNOSY AND RELATED SUBJECTS

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Introduction and Report of the Seminar

L. David Hiner, Chairman
University of Utah

I would rather leave the evaluation of the Seminar in the hands of those who attended. They are the ones who made it by their fine participation, and especially by their presence and cooperation in the meeting. It was a pleasure and an inspiration for the Utah group to have the honor of your presence. Confidentially, I almost didn't invite the group because of our very limited housing facilities. Then I recalled the splendid people who make up the Seminars in Pharmacognosy, and my enthusiasm got the better of my good judgment. You were cooperative, interested, and enthusiastic, and you were excellent guests. You won't ever be more welcome than you were in Zion.

In the Seminar we solved a lot of our problems, created some new ones, and generally revived the "spark" of Pharmacognosy. We had some good spots, some bad ones, and some that were down right inspirational. I am deeply grateful to all those of our group who participated in making the program a success. Special thanks goes to Dr. Lloyd E. Blauch for his assistance in the evaluation of our efforts. He fit so neatly into our group that I believe we could make a good pharmacognosist of him. My colleagues at Utah also deserve mention. Pharmacy was welcomed on this campus, and Dean Angleman and the rest reflected their pleasure at the caliber of men the Seminar attracted. Your broad interest in education has created respect for our profession.

The American Association of Colleges of Pharmacy was wise indeed when it conceived the Seminar plan, and no better money could be spent by the American Foundation for Pharmaceutical Education than that which supports these events. We are grateful for the aid of these two organizations.

To my committee, Drs. Youngken, Jr., and Claus, and Deans Burt, Daniels, and Zopf, my sincere thanks. I hope every local Seminar chairman is lucky enough to get a committee like mine. Wisdom, experience, imagination, and a sense of humor were theirs. I had everything in this group, and don't think the latter isn't necessary. Now because an official summary and evaluation are contained in this proceedings, let's have a look at some Seminar data.

There were 157 people registered for the events of the Seminar week. Of this number 92 were active in pharmaceutical education as deans or teachers. Nine students registered, 39 were wives and adult relatives, 11 were children, and 6 were Utah friends of Pharmacy who were interested in medicinal plants.

A total of 64 institutions were represented. Included in this group were 4 Canadian Universities, the University of Oslo, Norway, and the 1st Fouad University, Cairo, Egypt. A complete list of the American Colleges and Schools that were represented, and a distribution map are contained in this report. These are a testimony to the interest of educators and administrators in our colleges of pharmacy. It was a privilege to have served such a noble group, and in my prejudiced estimation I believe the 1953 Teachers' Seminar on Pharmacognosy and Related Subjects accomplished its objectives.

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(3) An Organized Approach to Natural Products through the Fundamental Consideration of Cellular Biosynthetic and Structural Processes . . . . H. W. Youngken, Jr.

(4) Relationships of Natural Products and their Derivatives to Allied Synthetics of Pharmaceutical Importance . . . . . Arthur E. Schwarting

(5) Integration of Natural Product Study with the Subject Matter of Other Professional Courses . W. R. Brewer

(6) The Learning and Proper Use of Scientific Vocabulary Related to Natural Products . . . Maynard W. Quimby

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(4) Bacteriology and Microbiology as a Prerequisite to Pharmacognosy . . . . . John G. Bachtold

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(3) Methods for the Orientation of Students in Pharmacognosy (A Panel Discussion) . . . . . M. R. Gibson
. . . . . J. A. Reese
. . . . . J. H. Hoch

(4) Belladonna from the Taxonomic Viewpoint . . . . . H. W. Youngken, Sr.

(5) Belladonna from the Phytochemical Viewpoint . . . . . W. R. Brewer

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(4) Specific Laboratory Subject Matter in Pharmacognosy . . . . . J. H. Hoch

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(6) Antibiotics in the Pharmacy Curriculum . . . . . Robertson Pratt

(7) Immunizing Biological Products . . . . John G. Bachtold

(8) Allergy and Allergens . . . . . E. P. Claus

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(4) The Future Began Yesterday . . . . . W. Paul Briggs

(5) The Objectives and Scope of Graduate Study in Pharmacognosy . . . . . H. W. Youngken, Jr.

(6) Some Comments on the Use of Elective Courses in the Graduate Program in Pharmacognosy . . . Robertson Pratt

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(8) Radioactive Tracer Techniques and their Application in Chemical and Biological Research . . . . . Thomas J. Parmley

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. . . . . W. R. Brewer
. . . . . Lloyd E. Blauch, Chairman

ADDENDA

(1) A Statistical Summary of a Paper Entitled, A Survey of Pharmacognosy . . . . . Raymond W. VanderWyk

(2) Practical Aspects of the Teaching of Pharmacognosy . . . . . Robert C. Stokes

Program for

TEACHERS' SEMINAR on PHARMACOGNOSY

and RELATED SUBJECTS, 1953

MONDAY, August 10, 1953

9:00 Registration

9:30 Announcements and Welcome
OBJECTIVES of the SEMINAR
Presiding: Dr. L. David Hiner, University of Utah

9:45 OBJECTIVES of the COURSE in PHARMACOGNOSY
(1) "The Study of Natural Products and their Derivatives as Pharmaceuticals"
Dr. E. P. Claus, University of Pittsburgh

10:15 Discussion

10:35 Intermission

10:45 (2) "An Organized Approach to Natural Products through the Fundamental Consideration of Cellular Biosynthetic and Structural Processes"
Dr. Heber W. Youngken, Jr., University of Washington

11:15 Discussion

11:35 Adjournment for Lunch

1:00 OBJECTIVES of the COURSE in PHARMACOGNOSY (continued)
Presiding: Dr. E. P. Claus, University of Pittsburgh
(3) "Relationships of Natural Products and their Derivatives to Allied Synthetics of Pharmaceutical Importance"
Dr. Arthur E. Schwarting, University of Connecticut

1:30 Discussion

1:50 (4) "Integration of Natural Product Study with the Subject Matter of Other Professional Courses"
Dr. Willis R. Brewer, University of Arizona

2:20 Discussion

2:40 Intermission

2:50 (5) "The Learning and Proper Use of Scientific Vocabulary Related to Natural Products"
Dr. Maynard W. Quimby, Massachusetts College of Pharmacy

3:20 Discussion

3:40 Trip through the UNIVERSITY of UTAH COLLEGE of PHARMACY

TUESDAY, August 11, 1953

9:00 BASIC PREREQUISITES NECESSARY for ACHIEVING the OBJECTIVES of PHARMACOGNOSY

Presiding: Louis C. Zopf, State University of Iowa

(1) "Botany and Zoology or General Biology"

(a) "Botany as a Basic Prerequisite for Undergraduate Pharmacognosy"

Dr. Frank L. Mercer, St. Louis College of Pharmacy

9:30 (b) "Zoology as a Basic Prerequisite for Undergraduate Pharmacognosy"

Dr. Stephen D. Durrant, University of Utah

10:00 (c) "General Biology as a Basic Prerequisite for Undergraduate Pharmacognosy"

Dr. Richard A. Deno, University of Michigan

10:30 Discussion

10:50 Intermission

11:00 (2) "General Bacteriology or Microbiology"

Dr. John G. Bachtold, University of Utah

11:30 Discussion

11:50 Adjournment for Lunch

1:00 BASIC PREREQUISITES (continued)

Presiding: Dr. Joseph B. Burt, University of Nebraska

(3) "Human Physiology and/ or Anatomy"

Dr. Ewart A. Swinyard, University of Utah

1:30 Discussion

1:50 (4) "Application of Organic Chemistry in Pharmacognosy"

Dr. Jack E. Orr, Montana State University

2:20 Discussion

2:40 Intermission

2:50 (5) "Other Desirable Prerequisite or Co-requisite Courses"

"Discussion by the group"

3:20 Discussion

3:30 E. L. Newcomb Memorial Award

Presented by Dr. Heber W. Youngken, Sr.

4:00 "Gathering Books and Herbs for the Saints"

Dr. L. H. Kirkpatrick, University of Utah

WEDNESDAY, August 12, 1953

9:00 **TEACHING METHODS**

Presiding: Dr. Troy C. Daniels, University of California

" The Philosophy of Teaching"
Dr. Sydney W. Angleman, University of Utah

9:30 Discussion

9:45 " The Learning Process in Science"
Dr. Lloyd E. Blauch, Department of Health, Education and Welfare

10:15 Discussion

10:30 Intermission

10:40 " Methods for the Orientation of Students in Pharmacognosy"
(A Panel Discussion)

(10:40 - 10:55 a.m.) Dr. M. Gibson, Washington State College
(10:55 - 11:10 a.m.) Dr. J. A. Reese, University of Kansas
(11:10 - 11:25 a.m.) Dr. J. H. Hoch, Medical College of South Carolina

11:25 Discussion

11:50 Adjournment for Lunch

1:00 METHODS of PRESENTING SPECIFIC DIDACTIC SUBJECT MATTER in the GENERAL COURSE of PHARMACOGNOSY

Presiding: Dr. Heber W. Youngken, Jr., University of Washington

(1) " Belladonna from the Taxonomic Viewpoint"
Dr. Heber W. Youngken, Sr., Massachusetts College of Pharmacy

1:30 Discussion

1:50 Intermission

2:00 (2) " Belladonna from the Phytochemical Viewpoint"
Dr. Willis R. Brewer, University of Arizona

2:30 Discussion

2:50 Intermission

3:00 (3) " Belladonna from the Physiological Viewpoint"
Dr. Frank L. Mercer, St. Louis College of Pharmacy

3:30 Discussion

7:00 Annual Plant Science Seminar watermelon party. University of Utah, Union Building Lawn

THURSDAY, August 13, 1953

9:00 CONTRIBUTION of the LABORATORY INSTRUCTION to the OBJECTIVES of PHARMACOGNOSY

Presiding: Dr. Willis R. Brewer, University of Arizona

" The Scope of Student Achievement in the Pharmacognosy Laboratory"
Dr. C. C. Albers, University of Texas

DEMONSTRATORS:

(9:30 - 9:50 a.m.)	Dr. J. A. Reese, University of Kansas
(9:50 - 10:10 a.m.)	Dr. M. Gibson, Washington State College
(10:10 - 10:30 a.m.)	Dr. J. Hampton Hoch, Medical College of South Carolina
(10:30 - 10:40 a.m.)	Dr. C. C. Albers, University of Texas

10:40 Summary and Discussion

10:50 Audio-Visual and Laboratory Instruments Exhibits.
A. A. C. P. Committee on Audio-Visual Education
Silge and Kuhne, San Francisco, California
Training Aids Exhibit - courtesy U. S. Navy
American Optical Company - courtesy Denver Fire Clay

11:50 Adjournment for Lunch

1:00 SPECIAL OFFERINGS in RELATED and ANCILLARY SUBJECTS

Presiding: Dr. Arthur E. Schwarting, University of Connecticut

" The Use of the Medicinal Plant Garden as a Teaching Aid in Pharmacognosy and Related Subjects"
Dr. Heber W. Youngken, Sr., Massachusetts College of Pharmacy

1:20 Discussion

1:30 " Antibiotics in the Pharmacy Curriculum"
Dr. Robertson Pratt, University of California

1:50 Discussion

2:00 " Immunizing Biological Products"
Dr. John G. Bachtold, University of Utah

2:20 Discussion

2:30 Intermission

2:40 " Allergy and Allergens"
Dr. E. P. Claus, University of Pittsburgh

3:00 Discussion

3:10 " Pesticides"
Dr. Maynard W. Quimby, Massachusetts College of Pharmacy

3:30 Discussion

3:40 General Discussion

FRIDAY, August 14, 1953

9:00 CORRELATING the SUBJECT MATTER of PHARMACOGNOSY and RELATED SUBJECTS with DISPENSING PHARMACY

Presiding: Dr. Heber W. Youngken, Sr., Massachusetts College of Pharmacy

" The Correlation of Pharmacognosy and Dispensing Pharmacy"
Dr. George E. Osborne, University of Utah

9:20 " Correlation of Pharmacognosy and Pharmacology"
Dr. Ewart A. Swinyard, University of Utah

9:40 Discussion

9:50 " Correlation of Pharmacognosy and Pharmaceutical Chemistry"
Dr. Jack E. Orr, Montana State University

10:10 Discussion

10:20 Intermission

10:30 PHARMACOGNOSY at the GRADUATE LEVEL

Presiding: Dr. Frank L. Mercer, St. Louis College of Pharmacy

" The Future Began Yesterday"
Dr. W. Paul Briggs, The American Foundation for Pharmaceutical Education

11:00 " Objectives of the Graduate Courses in Pharmacognosy and the Scope of Pharmacognosy Research"
Dr. Heber W. Youngken, Jr., University of Washington

11:20 " Effective Use of Elective Graduate Courses in Pharmacognosy"
Dr. Robertson Pratt, University of California

11:40 Discussion

11:50 Adjournment for Lunch

1:00 " Statistical Methods for Evaluating Experimental Research"
Dr. Edward G. Fingl, University of Utah

1:30 " Radioactive Tracer Techniques and their Application in Chemical and Biological Research"
Dr. Thomas J. Parmley, University of Utah

1:50 Discussion

2:00 " Methods of Stimulating Prospective Graduate Students for Study in Pharmacognosy and Related Biological Areas"
Dr. L. David Hiner, University of Utah

2:20 Discussion

2:30 Intermission

FRIDAY, August 14, 1953 (continued)

2:40 PHARMACOGNOSY at the GRADUATE LEVEL (continued)
" Qualifications for Pharmacognosy Teachers and Teacher-Training Programs in Pharmacognosy"
Dr. Richard A. Deno, University of Michigan

3:10 Discussion

3:20 " Minimum Physical Requirements for a Modern Pharmacognosy Department"
Dr. Arthur E. Schwarting, University of Connecticut

3:40 Discussion

3:50 SUMMARY and EVALUATION of the SEMINAR
Dr. Lloyd E. Blauch, Department of Health, Education and Welfare

4:20 Remarks from the Floor

4:30 Final Adjournment

7:00 Joint Pharmacognosy Teachers' — Plant Science Seminar Dinner
Dr. and Mrs. Reed S. Clegg, Host and Hostess

" When Deserts Bloom" An Illustrated Lecture
Dr. Walter P. Cottam, University of Utah

SATURDAY, August 15, 1953

9:00 Plant Science Seminar Field Trip

Assemble at Alpine Rose Lodge, Brighton Canyon. Ski lift ride to Summit.

Discussions:

(1) " Alpine Flora"
Professor Irving B. McNulty, University of Utah

(2) " Geology of Brighton Area"
Dr. Armand Eardley, University of Utah

(3) " History of the Old Mormon Trail"
Dr. Leland H. Creer, University of Utah

12:30 Box Lunch

4:30 Ski lift return

5:30 " Utah Chicken Dinner" - Maxfield's Alpine Lodge

Section A - SEMINAR DATA

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN

ALBANY COLLEGE of PHARMACY, UNION UNIVERSITY, Albany New York

Lauren R. Hanmer

AMERICAN COUNCIL on PHARMACEUTICAL EDUCATION, Chicago, Illinois

Melvin W. Green (and wife and son)

UNIVERSITY of ARIZONA, Tucson, Arizona

Willis R. Brewer (and wife and 2 children)

UNIVERSITY of ARKANSAS, Little Rock, Arkansas

Thaddeus S. Grosicki

UNIVERSITY of CALIFORNIA, San Francisco, California

Donald C. Brodie (and wife)
Troy C. Daniels (and wife and son)
Robertson Pratt
Alex Shrift

UNIVERSITY of CHATTANOOGA, Chattanooga, Tennessee

O. W. Grote (and wife)

UNIVERSITY of COLORADO, Boulder, Colorado

Charles F. Poe

COLUMBIA UNIVERSITY, New York, New York

Françoise A. Kelz (and mother)
Frank J. Pokorny

UNIVERSITY of CONNECTICUT, Storrs, Connecticut

H. G. Hewitt
Ara G. Paul
Arthur E. Schwarting
Varro E. Tyler, Jr.

DETROIT INSTITUTE of TECHNOLOGY, Detroit, Michigan

Curtis H. Waldon

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN (continued)

DRAKE UNIVERSITY, Des Moines, Iowa

James R. Weeks

DUQUESNE UNIVERSITY, Pittsburgh, Pennsylvania

V. H. Simonian

FERRIS INSTITUTE, Big Rapids, Michigan

Karlis K. Kazerovskis (and wife)

UNIVERSITY of FLORIDA, Gainesville, Florida

Carl H. Johnson

OFFICE of HEALTH, EDUCATION, and WELFARE, Washington, D. C.

Lloyd E. Blauch (and wife and son)

UNIVERSITY of HOUSTON, Houston, Texas

N. M. Ferguson (and wife and son)

HOWARD COLLEGE, Birmingham, Alabama

W. R. Byrum

HOWARD UNIVERSITY, Washington, D. C.

Chauncey I. Cooper
Phillip V. Hammond

STATE UNIVERSITY of IOWA, Iowa City, Iowa

Robert L. Van Horne
Louis C. Zopf (and wife)

UNIVERSITY of KANSAS, Lawrence, Kansas

J. Allen Reese

UNIVERSITY of KANSAS CITY, Kansas City, Missouri

Florence E. Neely

UNIVERSITY of LOUISVILLE, Louisville, Kentucky

Mrs. Margaret Clifford

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN (continued)

ELI LILLY and COMPANY, Indianapolis, Indiana

John E. Seybert

LONG ISLAND UNIVERSITY, Brooklyn, New York

Hugo H. Schaefer

UNIVERSITY of MARYLAND, Baltimore, Maryland

Frank J. Slama (and wife)

MASSACHUSETTS COLLEGE of PHARMACY, Boston, Massachusetts

Maynard W. Quimby (and wife)
Raymond W. Vander Wyk
Heber W. Youngken, Sr.

UNIVERSITY of MICHIGAN, Ann Arbor, Michigan

Richard A. Deno

UNIVERSITY of MISSISSIPPI, University Mississippi

W. W. Johnson (and wife)

MONTANA STATE UNIVERSITY, Missoula, Montana

Tracey G. Call
Jack E. Orr

UNIVERSITY of NEBRASKA, Lincoln, Nebraska

Joseph B Burt (and wife)
Rufus A. Lyman

UNIVERSITY of NORTH CAROLINA, Chapel Hill, North Carolina

H. R. Totten

OHIO NORTHERN UNIVERSITY, Ada, Ohio

Albert C. Smith

OREGON STATE COLLEGE, Corvallis, Oregon

Daniel P. N. Tsao

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN (continued)

PHILADELPHIA COLLEGE of PHARMACY, Philadelphia, Pennsylvania

Marin S. Dunn

UNIVERSITY of PITTSBURGH, Pittsburgh, Pennsylvania

Edward P. Claus (and wife)
Edward C. Reif
Stephen Wilson

PURDUE UNIVERSITY, Lafayette, Indiana

Gunnar Gjerstad
C. O. Lee (and wife)
Egil Ramstad (and wife)

RUTGERS UNIVERSITY, Newark, New Jersey

Maurice Bender

ST. JOHN'S UNIVERSITY, Brooklyn, New York

John L. Dandreau (and wife)

ST. LOUIS COLLEGE of PHARMACY and ALLIED SCIENCES, St. Louis, Missouri

Frank L. Mercer (and wife and 2 sons)

SMITHSONIAN INSTITUTION, Washington, D. C.

George Griffenhagen

UNIVERSITY of SOUTH CAROLINA, Columbia, South Carolina

R. C. Stokes

MEDICAL COLLEGE of SOUTH CAROLINA, Charleston, South Carolina

J. Hampton Hoch (and wife)

SOUTH DAKOTA STATE COLLEGE of AGRICULTURE and MECHANIC ARTS, Brookings, South Dakota

Kenneth Redman

UNIVERSITY of SOUTHERN CALIFORNIA, Los Angeles, California

Paul Kalemkiarian (and wife)
Catherine E Kirchner (and son)

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN (continued)

SOUTHERN COLLEGE of PHARMACY, Atlanta, Georgia

M. A. Chambers

SOUTHWESTERN STATE COLLEGE, Weatherford, Oklahoma

Paul E. Hering

TEMPLE UNIVERSITY, Philadelphia, Pennsylvania

Frank N. Eby (and wife)
James C. Munch (and wife)

UNIVERSITY of TENNESSEE, Memphis, Tennessee

Albert H. Musick

UNIVERSITY of TEXAS, Austin, Texas

C. C. Albers

TEXAS SOUTHERN UNIVERSITY, Houston, Texas

Hurd M. Jones, Jr., (and wife and son)

UNIVERSITY of TOLEDO, Toledo, Ohio

Charles H. Larwood

UNIVERSITY of UTAH, Salt Lake City, Utah

LeRay J. Anderson (and wife)
Sydney W. Angleman
John G. Bachtold
Reed S. Clegg (and wife)
Walter P. Cottam
Leland H. Creer
Stephen D. Durrant
Armand J. Eardley
Edward Fingl
L. David Hiner (and wife and daughter)
L. W. Knagenhjelm (and wife)
L. H. Kirkpatrick
Jack A. Madsen (and wife)
Irving B. McNulty
C. Dwayne Ogzewalla (and wife)
Geo. E. Osborne (and wife)
Thomas J. Parmley
Donald O. Schiffman (and wife)

REGISTRANTS and INSTITUTIONS REPRESENTED

AMERICAN (continued)

UNIVERSITY of UTAH, Salt Lake City, Utah (continued)

Douglas L. Smith (and wife)
Ewart A. Swinyard (and wife)
David H. Tedeschi
Richard L. Workman

UNIVERSITY of WASHINGTON, Seattle, Washington

Forest J. Goodrich (and wife)
Heber W. Youngken, Jr.

THE STATE COLLEGE of WASHINGTON, Pullman, Washington

Melvin R. Gibson

WAYNE UNIVERSITY, Detroit, Michigan

Harold E. Bailey (and wife)

UNIVERSITY of WISCONSIN, Madison, Wisconsin

Arthur H. Uhl
L. M. Parks (and wife and daughter)

UNIVERSITY of WYOMING, Laramie, Wyoming

Cleota Meyer
David W. O' Day (and wife and daughter)

XAVIER UNIVERSITY, New Orleans, Louisiana

Lawrence F. Ferring (and wife)

CANADIAN

UNIVERSITY of BRITISH COLUMBIA, Vancouver, B. C.

J. E. Halliday

MARITIME COLLEGE of PHARMACY, Halifax, Nova Scotia

J. Esmonde Cooke

UNIVERSITY of SASKATCHEWAN, Saskatoon, Saskatchewan

J. A. Wood

REGISTRANTS and INSTITUTIONS REPRESENTED

CANADIAN (continued)

UNIVERSITY of TORONTO, Toronto, Ontario

Ross M. Baxter
G. R. Paterson

NORWEGIAN

UNIVERSITY of OSLO, Oslo, Norway

Arnold Nordal

EGYPTIAN

Fouad I UNIVERSITY, Cairo, Egypt

Shafik Balbaa

SUMMARY of REGISTRANTS, 1953

Total Registration	157	
Teachers and/or deans	92	Including local participants in Plant Science and Teachers' Seminar programs. (Of these, at least 27 do not teach pharmacognosy)
Students	9	
Others	6	
Wives and guests	39	
Children	11	

GEOGRAPHIC AREAS REPRESENTED

States Represented 37
Canada
Egypt
Norway

INSTITUTIONS

SCHOOLS and COLLEGES REPRESENTED, 1953

AMERICAN

Albany College of Pharmacy
American Council on Pharmaceutical Education
University of Arizona
University of Arkansas
University of California
University of Chattanooga
University of Colorado
Columbia University
University of Connecticut
Detroit Institute of Technology
Drake University
Duquesne University
Ferris Institute
University of Florida
Office of Health, Education, and Welfare
University of Houston
Howard College
Howard University
State University of Iowa
University of Kansas
University of Kansas City
University of Louisville
Eli Lilly and Company
Long Island University
University of Maryland
Massachusetts College of Pharmacy
University of Michigan
University of Mississippi
Montana State University
University of Nebraska
University of North Carolina
Ohio Northern University
Oregon State College
Philadelphia College of Pharmacy and Science
University of Pittsburgh
Purdue University
Rutgers University
St. John's University
St. Louis College of Pharmacy and Allied Sciences
Smithsonian Institution
University of South Carolina
Medical College of South Carolina
South Dakota State College of Agriculture and Mechanic Arts
University of Southern California
Southern College of Pharmacy
Southwestern State College
Temple University
University of Tennessee
University of Texas
Texas Southern University
University of Toledo
University of Utah
University of Washington
The State College of Washington
Wayne University
University of Wisconsin
University of Wyoming
Xavier University

CANADIAN

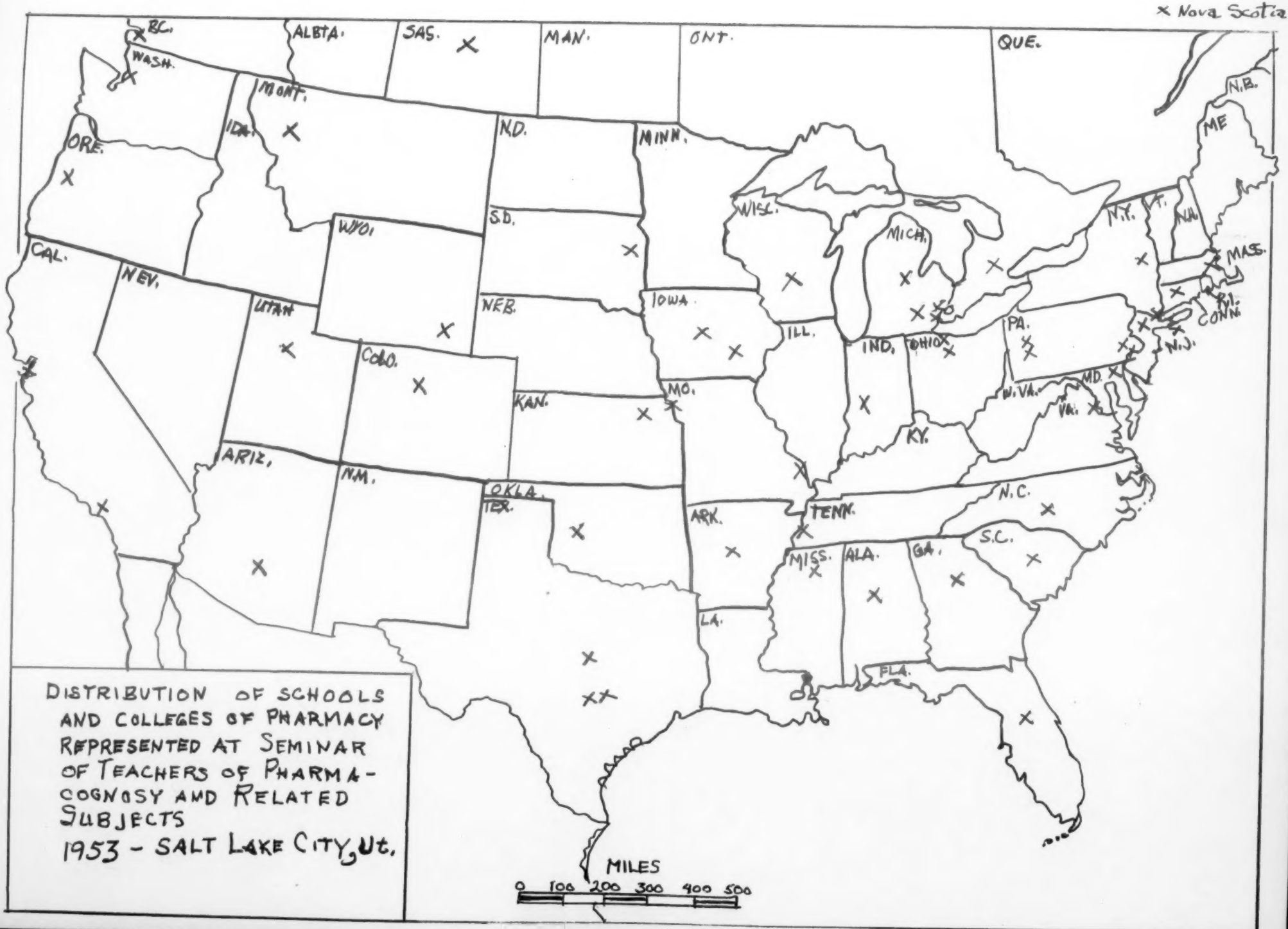
University of British Columbia
Maritime College of Pharmacy
University of Saskatchewan
University of Toronto

NORWEGIAN

University of Oslo

EGYPTIAN

Fouad I University


× Nova Scotia
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WISC.
MICH.
N.Y.
VT.
N.H.
MASS.
R.I.
CONN.
CAL.
NEV.
WYO.
NEB.
IOWA
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DISTRIBUTION OF SCHOOLS AND COLLEGES OF PHARMACY REPRESENTED AT SEMINAR OF TEACHERS OF PHARMACOGNOSY AND RELATED SUBJECTS
1953 - SALT LAKE CITY, Ut.
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Section B - OBJECTIVES of the COURSE

in

PHARMACOGNOSY

Introduction to the Seminar

L. David Hiner
University of Utah

The University of Utah was selected as the place for the 1953 Teachers' Seminar on Pharmacognosy and Related Subjects, and the week of August 10 to 14 was established as the dates on which it would convene. The National Plant Science Seminar elected to hold its annual meetings at the same time and place place because of the large number of persons wishing to attend both affairs. Thus Salt Lake City became the first city to entertain both Seminars and the Convention of the American Pharmaceutical Association in a single year.

The planning committee for the Teachers' Seminar met in the Hotel Utah in March of 1953. Messrs. Youngken Jr., Claus, Burt, Daniels, Zopf, and Hiner constituted the committee, and a complete and detailed program, together with an approved faculty resulted from the conference. It is of interest to note that only one member of the faculty selected for this meeting refused his assignment. Consequently we bring to you intact, the program and the faculty with but that one exception. The comments already made to the chairman indicate there is anticipated satisfaction and pleasure with the forthcoming meetings.

One of the most impressive things to me about the profession of pharmacy is its willingness to submit to self evaluation and self regulation. In the practical field self evaluation has lead both local and national pharmaceutical organizations to impose restrictions on the ethics of sale and distribution of dangerous drugs beyond that required by existing State and Federal laws. Now it is time we extended this program of self evaluation to the various segments of our pharmaceutical education program, so that it too will be given the same advantage of sympathetic scrutiny afforded the practical phase of our profession. These Seminars in fact are a form of self evaluation, segment by segment, and we have a skilled educator and his committee standing by to help us evaluate the final results. As a matter of fact I have asked these gentlemen to be prepared to bring in a final report at the conclusion of our meetings, in an attempt to get something specific, rather than generalizations for us to take back to our pharmacognosy teaching.

Objectives of the Seminar

The objectives of the Pharmacognosy Seminar appear rather clearly in the light of this self evaluation concept. It might be stated as simply as, 1) " The Evaluation and Improvement of Teaching Methods Applicable to the Proper Presentation of Pharmacognosy at the Undergraduate Level, " and 2) " The Same, but at the Graduate Level of Instruction. " However the statement, " Proper Presentation of Pharmacognosy, " requires additional listing of objectives, which in turn actually become the very body of this Seminar program. Since from it we hope to finally emerge with a clearer concept of the subject, and the place it fills in the pharmaceutical curricula, I offer for your consideration

these objectives of the subject called Pharmacognosy, or better yet, these become the things we hope it will accomplish, in fact they become the criteria for the future judgment of this subject in pharmaceutical education. As objectives we hope to accomplish --

1. The definition of Pharmacognosy as the study of natural products and their derivatives as useful pharmaceuticals.

2. The consideration of the fundamental aspects of cells as bio-synthetic and structural units of plant and animal life.

3. The study of the relationship of natural products and their derivatives to allied synthetics of pharmaceutical importance.

4. The proper integration of natural products study with the subject matter of the other professional courses in the pharmaceutical curriculum.

5. To encourage the development of advanced courses and research in Pharmacognosy leading to the study of this science at the graduate level.

6. The learning and proper use of scientific vocabulary related to natural products, and finally

7. The evaluation and improvement of teaching philosophy and methods applicable to achieving the foregoing objectives as herein set forth.

With these things in mind the general committee planned your program. Experts from all phases of pharmacognosy and related fields of study are assembled to contribute their knowledge and experience to yours, for the betterment of instruction in this basic science. Solutions to our many problems are possible, but that does not necessarily mean the solutions for everyone will be the same. I have a feeling that this is indeed a great occasion, and that pharmacognosists will emerge from this Seminar an inspired and cooperative group of educators. For this we are indebted forever to those who have made it possible. It is time now to get on with the Seminar.

The Study of Natural Products and Their Derivatives as Pharmaceuticals

Edward P. Claus
University of Pittsburgh

The metamorphosis of any science is characterized by a period of vigorous animation followed by a dormant interval which must be endured before an advanced stage develops. The science of pharmacognosy has been slow to emerge from its hibernation of scholastic inertia. Pharmacognosy at the turn of the century was featured by intense morphological and histological studies considered essential at a time when adulteration of crude and powdered drugs was rampant. The determination of foreign substances and substitutes was a major problem for those who found it necessary to purchase crude and powdered vegetable drugs. The sources of supply were not as dependable as they are today. No Food, Drug, and Cosmetic Act regulated the existence of a uniform product much less a drug or substance free from contamination. Substitution was common, and accurate recognition of plant parts, tissues, cells and cytoplasmic inclusions was considered the chief duty of the person trained in pharmacognostic techniques.

Since reputable manufacturing concerns began to employ specially trained pharmacognosists and chemical analysts, the drug importing companies, in self-defense, became quality-conscious. They found it necessary to analyze their own drugs and materials. Thus, increased vigilance on the part of both importing concerns and pharmaceutical manufacturing plants was reflected in the improved products supplied to the retail pharmacist. As a result, the pharmacist's knowledge of microscopy and histology fell into disuse and was gradually discarded. The teachers of pharmacognosy were slow to follow this trend possibly because they were still training or acting as microscopic analysts for the manufacturers and importers. Thus, the field of pharmacognosy some years ago began to suffer in the eyes of both the student and the practicing pharmacist since much of the instruction was deemed of little practical significance in retail pharmacy. The situation in which we find ourselves today is a state of turmoil between the adherents of what is called "traditional" pharmacognosy and the proponents of what is termed "modern" pharmacognosy.

The terms "traditional" and "modern" are not mine. Let me quote from Dr. Richard A. Deno (1) who, in discussing "Correlation of the Biological Sciences in the Pharmaceutical Curriculum" at the 1951 A. A. C. P. Teachers' Seminar on Pharmacology and Related Subjects, stated:

"However, that you may know what is meant here by each of these designations, pharmacognosy refers to the traditional pharmacognosy in contrast to the modern approach..... Please understand that the term is restricted to the traditional solely because a large majority of the accredited colleges teach only the traditional pharmacognosy today. I am wholly sympathetic, as is the American Council on Pharmaceutical Education, to a new scientifically sound approach to this or to any other subject in the pharmacy

curriculum."

Dr. Deno states further, in considering the modern approach that is taught in only about 10% of the colleges, "Probably this percentage will increase; it is also probable that the approach will not be universally adopted because many administrators believe that pharmacognosy should be restricted to the traditional, and that material added or reclassified as in the modern approach belongs in other courses. It is my opinion, as a pharmacist and biologist, that the modern school of pharmacognosists has many cogent arguments that are sound, both scientifically and educationally."

My subject "The Study of Natural Products and Their Derivatives as Pharmaceuticals" will not be a discussion of the advantages of one method of approach over another. Three viewpoints on the subject of approach will be presented later this week for your consideration. Neither do I intend to present a complete list of plant and animal drugs with their derived products as a guide for the teacher of pharmacognosy. I do wish to discuss: first, some suggestions concerning certain drugs and their derivatives and second, the amount of data on each drug which might be considered necessary or advantageous for the student's education.

Before beginning, we might ask ourselves this pertinent question: "What do we expect the course in pharmacognosy to accomplish for the student?" Naturally, your answer is undoubtedly different from mine, but this is my reply: The course in pharmacognosy equips the pharmacy student with serviceable as well as reserve information concerning certain natural drugs and their derivatives. The student recognizes the natural, chemical, and therapeutic relationships of these drugs and derivatives and he realizes that they are dependent upon biosynthetic metabolism of living plants and animals. He understands that modern laboratory ingenuity is based on the attempt to synthesize all natural products and to duplicate them, either by exact chemical composition or by similar pharmacological properties, in order to insure their constant availability to the medical profession. Through his learning in pharmacognosy he can grasp more easily certain portions of his course in pharmacology, drug assay, pharmaceutical chemistry, galenical pharmacy, dispensing pharmacy, and public health. He is able to read intelligently and interpret correctly the official compendia and the standard text and reference books in his field. In short, pharmacognosy should serve to inculcate an appreciation of the role plants and animals play in the fields of medicine and pharmacy, and also to equip him with specific data and background information that he will use in dealing with his professional associates.

In stating these objectives I have touched upon the other four subjects included in this day's schedule. Each of the remaining speakers will dwell upon certain phases of the "Objectives of the Course in Pharmacognosy."

An enlargement of these objectives has been presented by the Pharmaceutical Survey Committee (2) in its preliminary report entitled "Pharmacognosy in the Pharmaceutical Curriculum":

"Pharmacognosy in its comprehensive sense ..... extends beyond

the vegetable and animal products used for medicinal and pharmaceutical purposes. Many other materials of plant and animal origin, not used for medicinal purposes, such as commercial gums, waxes, oils, vegetable dyes, rubber and other latexes, plant and animal fibers, cereals, coffee, tea, and cocoa have been regarded as within the field of pharmacognosy. They have long been submitted to pharmacognosists for determination and evaluation. Most of them are, of course, outside the interest of pharmacy and therefore not germane to a course in pharmacognosy in an undergraduate pharmaceutical curriculum."

The wording of the next three paragraphs of this report is so apropos at this time that I would like to quote from it:

"One can readily understand the place of undergraduate instruction in pharmacognosy for students who plan to become teachers of the subject, for those who expect to take certain positions in drug manufacturing establishments, and for others who prepare for research work in certain fields, but the question may be asked as to what useful purpose it serves for retail pharmacists.

"True enough, the pharmacist is not called upon to stock his shelves with the great number of crude drugs which were considered essential in the earlier editions of the United States Pharmacopoeia and the National Formulary. However, he still has to handle many refined and crude drugs of plant and animal origin. His prescription department is stocked with the many and ever increasing principles isolated from those drugs, such as digitalis and ergot. Such products as the alkaoids, glycosides, gums, resins, waxes, and volatile and fixed oils are derived from plants about which the pharmacist should have knowledge. The vitamins, hormones, and antibiotics, and the sources from which they are derived should, of course, be of great interest to one who dispenses them.

"In short, knowledge of pharmacognosy enables the pharmacist to discuss intelligently with the physician those products of natural origin and their constituents concerning which he may be consulted. It increases the background of biological information the pharmacist needs to answer public queries. Adequate knowledge of the aspects of pharmacognosy that deal with the recognition of poisoning agents and their physiological action better qualifies the pharmacist to render service in the community in cases of accidental poisonings. That portion of the subject which deals with the economic factors under the sources, production, and commerce of raw materials and isolated constituents obviously prepares the student of retail pharmacy for everyday dealings in the buying and selling of products whose market values fluctuate periodically because of these factors. Such are some of the immediate uses the pharmacist makes of the subject in his daily service."

Let us assume that the student has acquired basic information regarding the generalities of official definitions, descriptive terminology, commercial forms, drug collection and processing, storage requirements, adulteration and substitution, and the fundamental knowledge which is a part of the undergraduate course in pharmacognosy. The question which follows is one I have often asked myself and, I am sure, each of you has pondered

it also: " What natural products and derivatives are most important to my students in pharmacognosy and just how much should they be expected to learn about these substances? What drugs are of lesser importance? What drugs should I mention only by title and synonym?"

As I indicated previously, let me suggest a few specific drug classifications for discussion:

1. Official crude drugs which yield official derivatives.

Digitalis, Belladonna, Cinchona, Opium, and Ergot are important drugs of the U.S.P. and N.F., you will agree, inasmuch as they yield digitoxin, atropine, scopolamine, quinine, quinidine, morphine, codeine, papaverine, ergonovine, and ergotamine. We would also agree, I am sure, that we should teach our students all we can of the crude drugs just mentioned. This would include titles, synonyms, history, geographic source, definition, commerce, description, identification, histology, microchemical tests, constituents, therapeutic properties, and dose. We probably would mention other points of interest: storage requirements, galenical preparations, descriptions of the growing plants, adulterants, etc. The constituents that are official should be studied in detail also, particularly as to definition, description, characteristic appearance, therapeutic use and dose. We might enlarge upon these with identity tests, solubility, glycosidal hydrolysis, alkaloidal precipitants, and other details which may or may not have been brought to the student's attention in introductory pharmacognosy. The laboratory exercises would include complete morphological and histologic examinations as well as tests for the identification of the crude drugs, such as the modified Grahe's test for Cinchona and the sclererythrin test for Ergot, and microchemical tests for the derivatives, such as the thalleioquin test for quinine and the sulfuric acid - selenous acid test for codeine.

In this same class of drugs Strophanthus, Colchicum Seed and Corm, Ipecac, Nux Vomica, Areca, Peppermint, Spearmint, Thyme, Caraway and other umbelliferous fruits, Sassafras, Cinnamon, Myristica, Clove, Cardamom Seed, Linseed, Nutgall, Rice Polishings, Liver Extract, Vanilla, Aloe, Aspidium, Bitter Orange Peel, and others which yield a variety of derived substances. Only some of these merit as much attention as those in the preceding paragraph.

2. Official drugs which yield no official derivatives.

These consist of crude drugs which are employed pharmaceutically in the whole or powdered form or made into official pharmaceutical preparations such as tinctures, fluidextracts, powdered extracts, syrups, and the like. Among the drugs are Cascara Sagrada, Acacia, Agar, Tragacanth, Wild Cherry, Black Mustard, Psyllium Seed, Benzoin, Tolu Balsam, Peruvian Balsam, Styrax, Cubeb, Squill, Witch Hazel Leaf, Aconite, Sarsaparilla, Myrrh, Gamboge, Asafetida, Glycyrrhiza, Quassia, Gentian, Senna, Rhubarb, Elm, Viburnum Opulus, and Viburnum Prunifolium. Here we have an assortment of U.S.P. and N.F. drugs, some of which are much more important than others. Shall the student be required to study each in a

complete manner? Depending upon the experience and the interest of the pharmacognosy teacher certain of these will receive more attention than others. But, should Quassia receive the same amount of time and emphasis as Cascara Sagrada? Should Styrax and Psyllium Seed be accorded equal consideration and should either utilize more or less time than Acacia?

Many of us are hesitant to delete the details of plant and animal drugs from our teaching. We realize that new material must be added to keep our course up-to-date, but instead of making room for the new by eliminating superfluous information about the old, we attempt to crowd all, both old and new, into the course with the result that the student is overwhelmed. He looks upon the course as a test of his power of memorization. For instance, what should the student know about Sarsaparilla? Isn't it sufficient for him to know that it is a root of Mexican, Central and South American Origin, contains saponin glycosides, is used as an alterative usually in combination with other drugs, and is a flavoring agent as the Compound Syrup? Is it necessary for him to recognize the drug either as a piece of the root or in a bundle of roots tied with roots of the same plant? Should he be familiar with the histological structure of the root and be able to identify it? Should he know that the endodermal cells in the different species may differ in wall thickness and that the cortex may be mealy, starchy, or horny? Is tracing powdered Sarsaparilla as an unknown in a key for powdered drugs expected to aid him in a practical way? In my opinion, much of this information is superfluous for a student who intends to follow retail pharmacy. I will agree that such details are essential to a course designed for the microscopic analyst, the research worker in pharmacognosy, the teacher of pharmacognosy, and others who have a special reason for such investigation. Obviously, such instruction should be relocated into either elective or graduate courses.

3. Official derivatives yielded by unofficial drugs.

Glycosides and neutral principles, ouabain, picrotoxin, rutin, and digoxin; alkaloids, cocaine, ephedrine, physostigmine, and pilocarpine; hormones, epinephrine, estradiol, progesterone, and testosterone; volatile oils, eucalyptus, lavender, rose and rosemary oils; fixed oils, castor, olive, peanut, and sesame oils; and miscellaneous substances, caffeine, camphor, and insulin are examples. Many of these are extremely important in modern therapeutics and deserve special attention by the pharmacognosy student. How much should he learn about the crude drugs from which they are derived? How often does the student handle or even observe coca leaves, ma huang, calabar beans, or jaborandi leaves? I feel that he should know each drug's synonym and associate the derivative with it. He should correlate adrenal gland, ovary, corpus luteum, and testis with the above-mentioned hormones. But, is it any more important that he identify the dried vegetable drugs than the dried animal glands?

4. Drugs formerly official which are: (a) used in proprietary preparations, (b) used by the laity in home medicines.

A study of current proprietary medicines reveals that certain unofficial drugs are consumed by the manufacturer in greater amounts than are certain official drugs. In a recent prescription survey conducted in

the Pittsburgh area (3) the Parke, Davis and Company preparation, Cosanyl, was called for 52 times which afforded it third place among all of the proprietaries. The ingredients of Cosanyl are Ethylmorphine Hydrochloride, Euphorbia Pilulifera Tincture, Compound Squill Syrup, Wild Lettuce Syrup, Cocillana Tincture, Bitterless Cascarin, Menthol, and Alcohol. Three drugs formerly official are listed; Euphorbia Pilulifera, Wild Lettuce, and Cocillana. What, if anything, should be taught of these drugs in the modern course in pharmacognosy? Should the names pill-bearing spurge, lactucarium, and guapi bark be mentioned by the teacher, or should the student be told that he should learn as many synonyms as possible for all unofficial drugs? The synonym "guapi bark" has appeared twice on state board examinations in Pennsylvania in the past five years. On the last board examination, in June of this year, one question asked for the synonym of Rhamnus Cathartica, a drug which has not been officially recognized since the N. F. VII. At this point I would like to quote Dean L. David Hiner (4) who admirably expressed himself on the subject of state board examinations at the 1951 Section of Teachers of Biological Sciences of the A. A. C. P. Conference of Teachers:

"To a great extent the boards of pharmacy dictate a great deal of what must still be taught in pharmacognosy. To illustrate, the writer does not contend that memorizing a mess of botanical sources is any mark of intelligence, but rather students should know the significance of official sources to the system of science, and to pharmacy and research. However, when we know that the state board examinations will embrace specific botanical origins it leaves us without choice, and we must belabor the students accordingly. To the suggestion that your state board examiners should be approached, the reply, that my own board does cooperate, but what about the examinations in the other forty-seven states. No, the only safe thing to do is to teach accordingly and further prejudice the poor student. So you teach B. O.'s and they are asked--everyone's happy. You teach them and they aren't asked. Everyone's mad! You don't teach them and they are asked. Everyone's mad again! What a dilemma it adds up to, and yet it doesn't appear that it is any worse in pharmacognosy than anything else. It just seems that way." I realize that we must be objective in our thinking and teaching, and that we are educating young men and women in an applied biological subject rather than merely preparing them to pass a state board examination. Nevertheless, if the marks of the graduates of a certain school are not up to par in the board examination in pharmacognosy, the teacher of that subject will undoubtedly be informed of that fact by the dean of the school.

What, then, should we discuss in the category of unofficial drugs? In stocking those substances used by the laity in making teas, infusions, and decoctions, the retail pharmacist probably handles more crude drugs than in all his other activities. If he buys his drugs in one-ounce packages, he probably never sees the contents. If he buys his drugs by the pound and sells them in small quantities, he should be able to identify them. Boneset, Chamomile, Saffron, Triticum, Marigold, and Bearberry are common examples. In these cases, it would not be amiss to mention the synonyms as well as the therapeutic uses and the doses. The identity could be left to the discretion of the teacher depending upon the section of the country or state

in which the school is located.

5. Drugs under clinical investigation or already in therapeutic use but which are not yet official.

This subject requires the pharmacognosy teacher to read the latest journals with the idea of learning the new drugs being studied by clinicians and physicians Visammin, the chief constituent of the fruit of Ammi visnaga, is a promising therapeutic agent in the treatment of angina pectoris. It occurs on the market under several trademarked names among them Khellin, Ammicardine and Eskel. Another of the newer investigations utilizes the root of Rauwolfia serpentina for the treatment of hypertension. Two trade products are Raudixin and Rauwiloid (the latter being a mixture of alkaloids obtained from the root). The re-investigations concerning the activity of the drug Veratrum Viride merit special mention. Hardly an issue of the Scientific Edition of the Journal of the American Pharmaceutical Association can be read without the observation that phytochemical studies are constantly in progress. The seeds of certain species of Strophanthus and the roots and underground stems of species of Dioscorea have, as we all know, been studied as possible sources of cortisone substitutes. The foregoing discussion will emphasize that the teacher must impress on his students that the fields of plant chemistry and drug plant investigation as well as pharmacognosy have been in existence for a long time and will continue to exist so long as there are inquisitive research-minded persons in those fields. Although the student is influenced by his personal observation of specific therapeutic agents during his apprenticeship in the present-day retail pharmacy, he must gain an insight into the changing medical world and the fact that new plant and animal drugs, new derivatives of natural products, and new synthetic chemicals will inevitably enter the market as therapeutic agents. He should be aware that modern scientific studies are improvements upon the "trial and error" methods employed by the African natives, American Indians, and the herbalists of ancient Greece, Babylon, Egypt, and Asia. The student should discover that science and progress are handmaidens and that the old cannot be completely cast aside since it provides basis for the new.

Natural products used as pharmaceuticals include, in addition to crude drugs and their derivatives, immunizing biologicals, antibiotics, and allergens. Although these may be classed as special entities, they fall within the scope of pharmacognosy. Regardless of whether the course in bacteriology or microbiology precedes or follows the course in pharmacognosy, and regardless of whether these products constitute an integral part of the subject matter of bacteriology or microbiology, the pharmacognosy teacher must, of necessity, offer specific instruction on vaccines, toxoids, antitoxins, antibacterial serums, human immune serums, globulins, and tuberculins. Immunizing biologicals are not true prescription items in the majority of cases nevertheless the retail pharmacy serves as a distribution center. From the standpoint of the practicing pharmacist, the student should be apprized of the proper method of storing biologicals and the importance of observing the expiration dates on the packages. In developing inter-professional relations he should know the types of immunity induced by the different

kinds of biologicals, their general method of manufacture, and the qualifying tests to which they have been subjected by the manufacturer. In this day of enlightened, science-conscious public, it behooves the pharmacist to acquire sufficient knowledge to answer his customer's questions authoritatively.

In the field of antibiotics, he finds public interest even keener since so much has appeared in popular magazines. Here, he should possess an up-to-the-minute information of all antibiotics, even those in clinical trial. The pharmacognosy teacher similarly should be informed of these also, regardless of whether they appear in the newest textbooks or not. Erythromycin, viomycin, neomycin, and fumagillin are only a few of the latest antibiotics to be released. What the student gains in his pharmacognosy course will be put to good use in studying antibiotics in his other professional courses, particularly in dispensing pharmacy. Caution must be exercised that all departments considering antibiotics do not cover exactly the same ground, and much can be accomplished in correlating the teaching on special subjects by inter-departmental conferences. May I call your attention to a paper by Dr. Lloyd M. Parks (5) who considered pharmacognosy at length during his discussion on correlation at the 1952 Teachers' Seminar on Pharmaceutical Chemistry. His comments are well worth your reading time.

Although allergens rarely are termed prescription items, those substances producing allergic symptoms generally arise from the plant and animal kingdoms and, therefore, must be added to the list of natural products used as pharmaceuticals. Some pharmaceutical manufacturers maintain special departments for the preparation of allergenic extracts. Although most allergists prefer to make their own extracts or to buy them made-to-order by certain firms, many purchase their injectables through the regular market. This is a fertile field in which the pharmacist can pioneer. The time is coming when the more commonly used allergenic extracts will be supplied to the physician by the pharmacist in a manner similar to the immunizing biologicals.

I have purposely treated the subjects of immunizing biologicals, antibiotics, and allergens lightly and have not touched upon pesticides at all since each of these topics will be discussed later this week. They represent new additions to the field of pharmacognosy and very definitely should become part of the subject matter to be taught in the undergraduate course.

In summary, the new natural products and their derivatives being employed as pharmaceuticals are more spectacular and more effective than many of the older drugs that have been used for years by the medical profession. We, as objective-minded pharmacognosy teachers must ruthlessly curry out the extraneous matter regarding the older drugs; indeed, we must completely eliminate those which are useless. In many instances this means that we must bid farewell to drugs which we have used as examples for most of our teaching years. We must re-plan our course in both didactic and laboratory instruction. Let us remember that we are equipping the present day student with useful training in natural products and their derivatives that he

can use advantageously in the future.

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An Organized Approach to the Study of Natural Products Through the Fundamental Consideration of Cellular Biosynthetic and Structural Processes

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During October, 1947, at the request of the Pharmaceutical Survey Committee and under the Assistant Director in Charge of Curriculum Studies, Dr. Lloyd E. Blauch, a committee of four pharmacognosy teachers assembled in Washington, D. C. to discuss and prepare a report on the present and future roles of pharmacognosy in the pharmaceutical curriculum. Additional consultants among teachers of pharmacognosy were contacted before the preliminary and final drafts of this important report were prepared so that as many details as possible within the physical realm of the function of the committee could be agreed upon. In January, 1948, the preliminary draft of the report, (1) was made available for all teachers of pharmacognosy and other interested pharmaceutical educators and in August, 1952, the report of the Pharmaceutical Survey, (2) was published in its final form. In both preliminary and final reports, among other details such as "practical aspects of pharmacognosy," historical development," need for revision," etc., there were stated what might be considered to be major "objectives" of the general course of pharmacognosy. Briefly the objectives which the report stipulated are paraphrased as follows and you will note that Dr. Hiner and Dr. Claus have dealt with them in the discussion which preceded this one. They include:

1. Knowledge of the constituents of products of biological origin having current medicinal and pharmaceutical importance. . . etc.
2. Knowledge of the pharmaceutic and therapeutic applications of natural products . . . etc.
3. Knowledge of the methods by which products of natural origin are evaluated . . . etc.
4. Knowledge of the production and commerce of natural products.
5. Understanding of the technical aspects . . . which are involved in the legal regulation of the products.
6. Knowledge of ancillary substances such as pesticides which are employed in the public health control.
7. Ability to use constructively biological concepts in the solution of new problems related to the public health.

Obviously these objectives may be stated in other words and several are too general and, paradoxically, not general enough depending upon how they are interpreted. In the main they are not revolutionary and not unlike objectives already stated in words to the same effect in the published text books and/or literature dealing with the subject. Foremost among the subject matter of the survey report and in subsequent writings which carry on from it, is the recognition that the study seeks emphasis of constituents or active chemical components of natural products and certain ancillary substances rather than upon raw drugs alone. Secondly, is the trend, as stated in the objectives, toward recognizing biological concepts as new problems arise. Although the latter is specifically referred in the report to those related to

the public health, these concepts may very well be related to science in general. But the objective of all professional courses is to direct the study toward pertinent aspects of the profession by an approach which will bridge the gap between the academic or basic information and the professional or applied knowledge.

The Survey report sought to spell out to a very limited extent the course content of an ideal general pharmacognosy course and suggested several outlines by which the course content might be arranged. Criticisms (3) from teachers who studied the details of these suggestions following the release of the "Preliminary Draft" in 1948, were generally favorable but significantly unfavorable among a minority of teachers and deans who read extreme duplication of subject matter in the pharmacognosy as proposed by the committee with other courses in the curriculum. In several instances critics had other points of view. The following quoted from correspondence (3) serve to reveal the thinking of some:

"I object to the attempt of the report to subordinate bacteriology, pharmacology, and biochemistry to pharmacognosy."

"It appears the committee report would re-do, under the guise of pharmacognosy, various chemistry, bacteriology, and pharmacology courses."

"I like the objectives of a course in pharmacognosy as set down on pages 8 and 9 of your report (the Preliminary Draft), but objectives are usually stated in generalities and unless implemented with a specific syllabus frequently mean little in application."

"In our opinion the material of the report is of little or no value to us. It tends to make pharmacognosy too all-inclusive and attempts to include in the course much subject matter which could be better covered in other courses."

Probably the chief reason for expressions such as these is the recommendation in the report to greater emphasis among the the chemical and physiological aspects of pharmacognosy than generally taught in recent years and because the report did not spell out in detail the subject matter which would fit the framework that was suggested. Several pharmaceutical educators, including pharmacognosy teachers, have seemingly lost sight of the original premise upon which the subject became formalized in the early 19th century as a science, namely, an organized approach to the study of the chemical, structural and physiological properties of vegetable and animal drugs. This was based upon the knowledge of the materia medica of that time and was the objective made evident in the many publications by pharmacognosists of the 19th century. A general emergence of other pharmaceutical sciences also developed from the "materia medica" of old and these, too, in some measure are concerned with chemical and physiological principles. For example, the science of pharmacology which is said to have begun as a formalized science under the teachings of Megendie during the early portion of the 19th century developed the approach to materia medica through the response of animal tissues to the drugs of the time, and this was the basis for American pharmacology under John Jacob Abel at the turn of the century. Much of pharmaceutical chemistry such as that which is

defined today as "organic chemistry in pharmacy" or "organic medicinal products" approaches "materia medica" through in vitro chemical synthesis and the relationship of structure to drug action, and it emerged with the concepts of chemotherapy as the result of the teachings of Paul Ehrlich, Emil Fischer, and others during the middle and late 19th century.

It is quite reasonable therefore to expect intimate relationships between all pharmaceutical sciences which arose each in its own right from a common chemistry and "materia medica." But from the beginning, the approach to the modern "materia medica" by the respective pharmaceutical sciences has in some manner followed different forms of emphasis and thereby has been identified on this basis. Today, pharmacognosy emphasizes chemical and biological relationships among drug products from plant and animals, including relationships among organisms that produce them. Pharmacology emphasizes the cell and tissue response to drugs of diverse types. Pharmaceutical chemistry emphasizes the synthesis and structural relationship among drugs, including chemical analyses. The subject pharmacy concerns itself with the processes and procedures for manufacture dispensing and dissemination of drugs to society. The end-product or drug and its pharmacodynamic uses might very well be a common meeting ground for all four areas.

In the basic science world a similar common meeting ground exists among the several objectives inherent in biological, chemical, and physical sciences as each seeks to approach an ultimate understanding of the atom, its properties, and functions in the atomic sphere of the biological and physical world. It is increasingly evident that a basic science course in human anatomy or biochemistry, for example, among other fundamentals, cannot be taught without reference to quantum mechanics and atomic space relationships. A most recent textbook of general biochemistry (4) defines the subject in a broader aspect as " . . . the study of the nature of the chemical constituents of living matter and of the chemical substances produced by living things; the functions and transformations of these chemical entities in biological systems; and the chemical and energetic changes associated, with these transformations . . . " How similar this definition is to that in an original organic chemistry text by the Swedish chemist, Berzelius, who in 1806 stated, "The part of physiology which describes the composition of living bodies, and the chemical processes which occur in them, is termed organic chemistry." Yet, I wonder how many medical scientists of the day will regard either biochemistry or anatomy as "catch-alls" for all basic science courses. And what organic chemist would cry "thief" in the face of the biochemist because the latter treats of organic chemistry.

Since the "Preliminary draft" of the Survey report previously referred to a few published papers (5-8) and one textbook (9) have appeared which define more clearly how certain objectives of pharmacognosy might be implemented in the undergraduate course with greater stress on chemistry and physiology and can be correlated with other courses. However, it is difficult to say that even these have satisfied critics who have expressed themselves as previously quoted. As has been suggested by the Report, (2) one cannot escape the fact that the subject matter must deal in some fashion with the properties and uses

of products germane to pharmacy and the public health. As a science originally developed, in its own right on the fundamental chemistry and biology of its time, it should continue to develop on the chemistry and biology of the present and future time. This approach is basic among all applied pharmaceutical sciences and represents at least one objective which all possess in common.

There are diverse methods by which the subject matter dealt with in the basic sciences can be applied to pharmaceutical sciences. Differences are largely dependent upon the approach to that which is emphasized. And, of course, what is emphasized depends upon the overall objectives of the science. If we analyze the objectives in pharmacognosy more critically in terms of specifically what its framework includes, we can say that basically it concerns itself with the biological chemistry and structural components of the cell. This includes essential metabolites as well as end-products of metabolic actions. All are fundamental to the organism and its parts which comprise the whole. The end-products of cellular metabolism comprise most of the natural products with which pharmacognosy deals. These may be highly refined entities or they may be rather composite chemical and structural mixtures. The approach to the function of the cell and its multiple forms (the tissues) in relationship to the diverse types of products which they form can develop through a series of quite related steps. Fundamental concepts of biology and chemistry loom large in each of these methods of approach. First, there are the numerous chemical classes to which important natural drug products belong, then the individual constituents as the properties of these are related to each other and to the class in which each can be placed. The basic chemical and biological principles underlying their separation, isolation, and evaluation are a part of the story. Next, and unique to pharmacognosy, is the significance of these elaborated materials to the biosynthetic processes and functions of the organisms in which they are found. This is an important part of the story and we shall return to this aspect later in the discussion. Then there follows the detailed approach to significant knowledge of the natural product as a drug substance such as its distribution and abundance in the organism from which it is commercially processed. This involves a detailed study of its sources among nature, the significant parts of plants and animals employed, the interrelationships of organisms and their tissues from which these parts are obtained and the biochemistry applied to these interrelationships. Principles of plant propagation, plant physiology and the laws of genetics are approached in treating of drug plant growth and cultivation which frequently has application as a part of this knowledge. Finally, the objective is to associate the knowledge of products of cellular metabolism with the general methods for their evaluation as drugs and for the pharmacodynamic uses for which they are important in pharmacy and the public health. It is the objective of most teachers to integrate all of these phases as they best fit the dynamic natural history and applied aspects of it in dealing with a subject (a natural product) vital to pharmacy and medicine.

The objective to organize the above approach through the consideration of biosynthetic processes, to which we shall now return, means that from the beginning we seek to tie together the various chemical and structural entities and their properties with chemical functions taking place within the cell. Quite naturally complete events in most biosynthetic processes or cellular biochemistry

remain obscure and it would help our teaching were more well established knowledge available particularly in regard to the biosynthesis of many naturally occuring drug substances. However, the assumption can be employed that the chemical constituents of cells have biochemical relationships and, in fact, our approach in this regard can make use of the biochemical knowledge already made available. Certainly, for example, among cellular principles, categories such as organic acids, carbohydrates, glycosides, alkaloids, terpenes, hormones, and enzymes can be closely interrelated through the consideration of well establish biosynthetic processes. Reference to some of these in our teaching makes the subject of the respective constituents more than mere isolated facts.

Teaching in pharmacognosy can at this point approach the biochemical interrelations among cellular constituents through such well known processes as photosynthesis and the several modifications of the Krebs cycle. Photosynthesis is a topic dealt with in basic biology, for example botany. But it does not usually progress beyond the descriptive story of elementary physical and chemical facts in these science courses. Aspects of photosynthesis which are related to the formation of end-products of cell metabolism can be applied to pharmacognosy. Later and associated with these two fundamental considerations the focus of biosynthesis and movement of cellular constituents can be interrelated during the consideration of the sources and distribution of natural drug substances in the organisms that produce them.

As you undoubtedly know, the fundamental approach to the biosynthetic processes of the Krebs cycle or its modifications necessitates careful consideration of the subject of enzymes; their nomenclature and general properties. These are the organic catalysts many of which serve as reactors for explaining the integral steps of cellular synthesis. Therefore, our objective to organize this phase of the study might best be achieved by commencing with a review discussion of enzyme properties. Certainly organic chemistry deals with all types of chemical compounds from a basic approach, but nevertheless the student in pharmacognosy is now ready for applications of organic principles and to do this there must continuously be reference to the properties of organic molecules and their classes.

The Krebs cycle concerns itself with various pathways of cellular synthesis applicable to a knowledge of the metabolites of organisms and in their interrelationships it not only links together individual components endogenous to plants or animals, but also many common to both.

Through various aspects of the cycle from processes such as the interconversion of organic acids, namely, pyruvic, oxalacetic, citric, aconitic and glutaric acids; or from phosphorylation of hexoses; or from nitrogen exchanges which involve transamination reactions the presence and interrelationships of many cellular compounds can be explained. A few specific processes which prove valuable in organizing fundamental biosynthetic processes with which a study in pharmacognosy can be associated include such interrelations as glutaric and aspartic acids to glutamines, asparagines and alkaloids; fats, fatty acids and sterols from 2-carbon acids and carbohydrates; polysaccharides including starch, gums and mucilages from glucose; glycogen and glucose relationships with hormone functions; terpene biosynthesis from isoprenes; purine and/or

xanthines from urea; the course of carbon in photosynthesis, enzyme function (hexokinase) in glyconeogenesis; inorganic elements and their role in carbohydrate, protein and organic acid biosynthesis; and other similarly related intermediates of end-product formation.

All of these specific reactions can be interspersed throughout the pharmacognosy of natural products so that their importance in the organism producing them can be dynamically related to their pharmacodynamic uses.

Should this appear to be a hodge-podge of biological chemistry in pharmacognosy, I should like to make it clear that the objective intended is merely an organized interrelation in the general pharmacognosy course of those biosynthetic processes for which there is good evidence to tie together the chemical classes and units of compounds which become the constituents dealt with as drug entities. Such a consideration serves also to apply the chemical parts of the cell with the organism as a whole.

It is not intended that pharmacognosy be a basic course in biochemistry. It is intended that the products which are to form the bases for certain pharmaceutical compounds and therapeutic uses be associated with the chemistry of the unit in which they are synthesized. Without this reference the biological and chemical aspects of pharmacognosy would seem to be incomplete. This is but one objective of the science, but it is an important one from a pedigogical point of view for it stimulates student reasoning to the fact that the cell is a chemical factory which operates in an orderly fashion. Furthermore, it poses many challenges for the inquisitive mind which seeks to regard the nature about him as an integral part of his chemical living.

Through such an organized approach on biochemical fundamentals the students achieve that much more of a background of the significance of natural drug substances in the overall activities of cell and tissue functions. It is important that he do so for a better understanding of the pharmacological actions of all drugs. For it is also through biochemical explanations that much of the subject of pharmacology, a course which follows pharmacognosy, is now dependent. The occurence of sugar, starch, lignin, calcium, oxalate, hyoscyamine, digitoxin, mucilage, oil, insulin, thyroxin, corticosterones as end-products of cell metabolism is dynamic; the biochemical incidents inducive to their presence and applications is biologically dynamic. Is not the application of the latter also vital knowledge in the production of natural products?

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Relationships of Natural Products and Their Derivatives to Allied Synthetics of Pharmaceutical Importance

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The title of this paper is obviously derived from the volume The Pharmaceutical Curriculum where under the heading Definition and Scope of Pharmacognosy it is stated " The subject also embraces the study of constituents..... It may include reference to those synthetic substances that are related chemically or physiologically to products of biological origin. "

The question that has confronted many educators since this report has been issued is the relationship between curricular material associated with natural products and synthetic products. There is open suspicion that pharmacognosists following a chemical pattern of organization may be ranging far and wide in their subject matter. The purpose of the present paper is therefore two fold; to quench those suspicions by establishing the boundries of general pharmacognosy, particularly with reference to synthetic chemicals and to illustrate the simple features and objectives of a chemical plan of organization. I have never fostered the idea that Pharmacognosy is anything but pharmacognosy and I believe the majority of professional pharmacognosists will agree that the inclusion of atabrine or methadon as subject matter in general pharmacognosy is a misappropriation of subject matter. These materials are properly introduced and correlated chemically in courses in pharmaceutical chemistry and physiologically in pharmacology. Pharmacognosy, however must concern itself with things chemical. Organic materials constitute the majority of drug substances and in the pharmaceutical curriculum considerable time is devoted to the sources, properties, formulations and functions of these materials. Pharmacognosy, described historically has largely been concerned with the physical description of plant and animal tissues used as drugs or as sources of drugs. There are many educators who propose to restrain our science within this ancient objective and to let it remain a smothered servant while other sciences steal the very soul of a subject that exists as the singular science peculiar to pharmacy. It is not the responsibility of other pharmaceutical sciences, to provide the student with a familiarity with sources, isolation, nomenclature, etc., of natural products even though they are related to synthetic materials by chemical design or physiologically. It would seem to me that these disciplines have created a situation that promotes needless duplication when quite openly they describe their sciences in certain definitions that qualify as pharmacognostic specifications.

In my contacts with reputable teachers of professional courses of our curricula over the years I have always been impressed with the fact that many do not visualize a pharmacognosy of steroids, antibiotics, vitamins, toxoids, etc., but see in these and other groups the traditional materia-medica approach that is all too common in many course offerings in professional pharmacy. The majority deny the right of pharmacognosy to exist as an adaptable subject.

I have deliberately strayed from the heart of the title. I have done this because I have some rather strong feelings on what constitutes pharmacognosy and contend that a large part of pharmacognosy is being taught in courses not under that label. At the same time it should be stated that a pharmacognosist is rarely justified in considering or correlating synthetic substances in his course. The chemistry, pharmacology and pharmacy of the several epedrines is no different regardless of source, while there is a pharmacognosy of those ephedrines obtained naturally. Yet there are occasions or areas of subject matter where a course in pharmacognosy needs to contend with materials of synthetic origin. The following are examples and the conditions under which they may become pharmacognosy are cited.

1. When products are obtained from higher plants or animals and by synthesis--

Many examples might be cited and included are caffeine, methyl salicylate, anethol, epinephrine, etc. The fact that these compounds are of dual origin suggests quality, economic and physiological comparison. Correlation of material of this kind with the subject matter of pharmaceutical chemistry is necessary and understandings among teachers of the several areas must be obtained.

2. When products are produced by fermentation and by synthesis --

Chloromycetin, various organic acids, sugar alcohols, etc., are obtainable by various methods using microorganisms or by synthesis. The natural processes and conditions by which these substances are produced and isolated are peculiar to pharmacognosy.

3. The products of plants or animals that are intermediates in the synthesis of drugs--

The intermediates and the biosynthesis of intermediates in l-ephedrine synthesis, the bio-oxidation of steroids and sugars and the terpenoids used in the products of menthol, etc., are examples of products or processes that remain peculiar to pharmacognosy.

4. Certain Toxicicants-- The inclusion of insect and pest control and plant growth regulation as subject matter in pharmacognosy is traditional. Yet the majority of these materials used for such purposes are not of natural origin. Need the student acquire this knowledge in general pharmacognosy? I see no reason for the inclusion of a discussion about Paris Green in general pharmacognosy. In those agricultural areas where pharmacists need to have this material presented as organized subject matter beyond the scope of its general presentation in basic courses, an elective subject should be provided. In general pharmacognosy colchicine, indolacetic acid, coumarin, rotenone, etc., are properly presented in the groups in which they fall.

The primary objective of pharmacognosy must be to provide the basis for a biological and chemical understanding of plants and animals yielding drug substances. To be taught as a vigorous science and to be recognized as an independent science it must be creative and within itself it must be so organized and defined that it can defend itself.

To determine the ultimate merits of a given course is difficult but it can be appraised. My experience as a student and as a teacher cause me to recognize thought provocation, rational thinking, thoroughness of understanding, enthusiasm and satisfaction as a measure of my teaching method and my subject. The course content at the same time must be appropriate to the objectives to be accomplished. I have concluded that a basic chemical characterization of plants with departures within these groups along a taxonomic or biological activity pattern offers the most ideal system. The principles of morphology, taxonomy and chemistry having been previously obtained the student is receptive and the instructor can easily mobilize the students faculties to understand natural products used as drugs.

There is no claim for originality in the chemical plan for I know that some instructors have used systems of this type before my academic career began and several texts of pharmacognosy have been written which follow a chemical classification. It is in this pattern of organization that some may visualize a relationship with synthetic products. The relationship to synthetic chemicals is not a direct one. A classification based on functional groups or physicochemical properties is somewhat useless in pharmacognosy whereas a grouping based upon the structural class without regard to chemical or pharmacologic properties serves the desired purpose. It is not necessary in pharmacognosy to distinguish exactly among digitoxin, diosgenin or estrone chemically or pharmacologically but to rather consider these principles, and their sources, as cyclopentenophenanthrene derivatives or as drugs yielding these principles. The system makes use of chemistry and other sciences, therefore, only as a means of executing a design, by building on a background and establishing a continuity between the basic sciences and the adaptation in other courses. If, at the same time, the pharmacognosist recognizes a chemical ontogeny, it is possible to create an organization that is scientific and one which is distinctive.

It is impossible here for me to case the various features of a course which follows a chemical organization. This problem becomes a responsibility of each of you interested in such a plan in your own faculty. For sake of clarity however I present the following scheme which represents a portion of the subject matter general pharmacognosy to illustrate the features of an organization based upon The group of drugs represented in this outline is not complete with respect to source or principle and is that part of a group which follows carbohydrates and their derivatives in the classification plan.

The introductory members are the simple benzenoid structures, such as:

Hydroquinone	(Arctostophylos)
Guaiacol	(Guaiacum)
Benzyl alcohol	(Myroxylon)
Salicylic acid	(Gaultheria)
Benzaldehyde	(Prunus)

The more complex derivatives include the following:

Gallic acid	(Hamamelis)
Aspidinol	(Dryopteris)
Rotenone	(Derris)
Rutin	(Fagopyrum)
Podophyllotoxin	(Podophyllum)
Emodin	(Rheum)

The basic plan of organization illustrated in this table features the simple derivatives of the benzene nucleus at the beginning with increasing complexity as further principles are introduced. This plan exhibits a bio-genetic relationship that can be achieved with other groups of natural occurring compounds and is therefore not an attempt to distinguish among the functional groups of the several compounds or to separate heterocyclic compounds from other chemical types. I choose to omit such compounds as Vitamin K_1 since the materially occurring vitamins as well as the antibiotics are presented as separate groups. The outline illustrates the opportunity for comparison or correlation of related synthetics. The occasion to describe such compounds as mercuric salicylate, dicoumarin, etc., exists but their inclusion in general pharmacognosy is unwarranted. Benzaldehyde occurring in glycosidal combination is also produced synthetically and even though this situation exists, here as well as otherwise, it does not preclude a consideration of the source of a naturally occurring compound in general pharmacognosy. In conclusion, the table illustrates a point of controversy among pharmacognosists. Podophyllum generally is considered as a resin containing drug. A physical description serves no real useful purpose to pharmacists and in the system which is proposed the major principle of a drug determines its position. This reasoning is applicable to Jalap, Storax, Acacia, Aspidium and other resinous, balsamic or polymeric drugs.

The theme which I have presented represents a justification for a chemical organization of naturally occurring substances. It is intended to offer an explanation of the basis for a departure from traditional pharmacognosy according to a plan which uses chemistry but does not teach chemistry. A system of chemical organization of the pharmacognosy of natural products is one which extends the chemical curiosity of a pharmacy student to an understanding which is functional permitting adaptation and insuring the student and future practitioner with a better capacity to understand modern experimentation in a pharmaceutical science.

Integration of Natural Product Study With the Subject Matter of Other Professional Courses

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The problem of integrating natural product study with other pharmacy courses is of dual nature. It involves:

(a) the inter-relation of the subject matter of professional courses so that they provide complete coverage but avoid needless duplication, and

(b) the location of the professional courses in the curriculum provide the proper sequence for the most efficient training of future pharmacists.

This latter phase of the problem is further complicated. First, the curricula vary from one institution to another and a plan for the integration of courses in a proper sequence for one school may not be suitable for another. On the other hand, it has been recognized that variation and flexibility in educational programs is a desirable situation, worthy of continuation. (1) Second, the exposure of one's ideas on integration to the consideration of others gives rise to divergence of opinion because the concepts of course content and curricular value are even less consistent among individuals than are the curricular programs among institutions. The story is told that in days gone by, a pharmacognosist once discounted the opinions of two of his colleagues on the grounds that they were "merely pharmaceutical chemists." Fortunately we are progressing beyond such narrow paths of intellectual barbarism and all such thoughts have long since perished, but one's field of specialization may still influence his concepts.

There are undoubtedly many other factors which multiply the complexity of the problem of integrating the professional courses, but a third and final one for this enumeration is the factor of a current state of transition in pharmacy. With the development of isolated medicinal constituents from plant and animal tissues during the latter part of the 19th century and the birth of chemotherapy at the turn of the century, amazingly rapid changes began to take place in the "art and science of the apothecary." Those who have been practicing pharmacy since the early 1900's have personally witnessed the change of typical prescription ingredients from tinctures, decoctions and fluidextracts to pure natural alkaloids, glycosides and resins or their synthetic substitutes and derivatives. They deplore that at present even these substances are but rarely employed by the retail pharmacist because the prescription calls for them in the form of a manufactured tablet, capsule or solution.

Among the rapid changes taking place in pharmacy is that in the science of pharmacognosy, the teaching of which constitutes the major effort of our colleges on behalf of their students in the field of medicinal natural products of biological origin. In this course there has been a marked shift from emphasis on the crude drug *per se* to the study of its active constituents. (2) In the heyday of the tincture and decoction, knowledge about crude drugs was

important preliminary information for the making of such preparations and pharmacognosy was taught as a pre-requisite or co-requisite for galenical pharmacy. Today, however, in keeping pace with the changing situation, the pharmacognosy course has different objectives, requires different pre-requisites, and is given a different sequential location in the curriculum.

The new role of pharmacognosy is that of a course allied with two others which deal, at least partially, with natural products--inorganic and organic medicinal products. The three provide a complete coverage of the properties and sources of medicinal substances of both natural and synthetic and of both biological and mineral origin. Obviously, such courses must be preceded by the general offerings in inorganic and organic chemistry. In order that their pharmaceutical and medical applications may be thoroughly understood, they should also be preceded by botany and zoology or biology, by biochemistry, bacteriology, anatomy, physiology and beginning courses in pharmacy. Such a background plus the successful study of natural and synthetic medicinal products should well equip a student for his encounter with the subsequent professional courses in pharmacology, toxicology, public health and dispensing pharmacy.

In returning to a consideration of the first phase of the problem enumerated at the beginning of this paper, it should be stated again, as it has been done many times in past issues of the American Journal of Pharmaceutical Education, that the integration of subject matter of any of our pharmacy courses is a product of cooperation and sincere interest in good teaching on the part of the teachers of those courses. Each must know what is being taught by the others if excessive duplication is to be avoided and completeness assured. Many writers have suggested frequent conferences of faculty members for the improvement of correlation of class work. In order to further enhance the efforts of individual teachers toward integration of course material, Bonisteel (3) has recommended that the members of each annual class be convened in a meeting with a member or members of the faculty every week of the school sessions so that the information presented in all courses during the preceding six days could be correlated, with emphasis placed on the value of the separate course materials to pharmacy as a whole.

The advantages of this kind of effort on the part of the faculty members as stressed by numerous authors (3, 4, 5, 6) lie in increased meaning to the student, greater efficiency in teaching, avoidance of contrasting information with its resulting confusion, and avoidance of duplication and omission. These advantages may also be categorized as the aims of integration. Writing on this subject, Vanderwyk (7) stated that correlation with other courses impresses upon the student that pharmacognosy is not an isolated offering of useless and outdated information as has been charged on past occasions.

Several authors have already made specific recommendations for integrating the subject matter of pharmacognosy with other courses. Bonisteel (3) suggested that the use of the microscope be taught in detail in an early course in the biological sequence and not repeated in pharmacognosy and all other courses in which the instrument is employed as a tool. To this, he added the same

suggestion regarding the basic study of living cells and their functions, pointing out that these topics may be covered in as many as nine different courses in the pharmacy curriculum. He also appealed for more correlation between the botanical subject matter of pharmacognosy and the study of the United States Pharmacopoeia and the National Formulary. Hiner (4) has commented upon the need for close cooperation between the instructors of pharmacognosy and pharmacology in order to avoid overlapping, duplication, omission and contrasting and confusing information. On the same subjects, Redman (5) has implied that the relationship between the chemical constitution of drugs and their pharmacological action brings modern pharmacognosy and pharmacology into position for ready integration. He also appealed for elimination of excessive duplication of subject material using, as an example, the coverage and possible duplication of the study of Vitamin A in six different courses of the curriculum.

Stoklosa (6) in an exemplary paper aimed at integration between pharmacognosy and dispensing pharmacy has shown, by means of specific prescriptions and commentaries, how pharmacognosy can become more meaningful to the student and dispensing practice more efficient through correlation between natural product study and " dispensing points. "

In a recent paper, Vanderwyk (7) has suggested some means of correlating pharmacognosy with courses in chemistry, dispensing pharmacy and bacteriology. Among these suggestions are:

a. The inclusion in pharmacognosy of simple chemical procedures involved in official identity tests of plant constituents.

b. The preparation by students of drug cards which contain notes on physical or chemical properties of drugs which evoke problems in dispensing. It is pointed out that these cards may be used in the dispensing pharmacy laboratory and the pharmacy following graduation.

c. The teaching of information on manufactured prescription specialties related to the drugs as they are studied in pharmacognosy.

d. The correlation by pharmacognosy and bacteriology instructors of the study of biologically produced antibiotics through the division of subject matter as follows:

Pharmacognosy --
- Chemical properties
- Physical properties
- Advantages and disadvantages
- Dosage
- Prescription specialties

Bacteriology --
Theories of action
Synergism
Antagonism
Spectra of action
Laboratory procedures

A possible integration of pharmacognosy with pharmaceutical administration offerings has been considered briefly by Schwarting and Youngken, Jr. (8) They advocated the addition of problems relative to trade and commerce in the study of drugs "to give the student an up-to-date picture of drug demand, production and pricing."

Although these writers have concerned themselves with pharmacognosy and its integration, the principles recommended apply to natural product study in general whether the products are of biological or mineral origin and whether they are included in pharmacognosy or pharmaceutical chemistry. The correlation of chemical and physical properties with "dispensing points" is as vital to the student in the latter course as in the former. With a little effort, any instructor can locate prescriptions and appropriate commentaries for all the natural products of importance in compounding. The examples suggested by Stoklosa as a contribution toward the course in dispensing pharmacy are only a good beginning.

One type of integration rarely discussed in the literature, yet often employed, is that of retroversion. Emphasis is usually placed on correlations with courses which are offered concurrently or subsequently, but integration may look back as well. For example, as a drug is discussed in pharmacognosy, reference may be made to certain historical events considered in a previous course such as pharmaceutical history or orientation. Retroverse references are likewise appropriate, from the standpoint of the teacher of natural products, when integration is planned with the courses in fundamental principles of pharmacy and pharmaceutical preparations. In the discussion of an alkaloid bearing drug, the reference to an appropriate extraction process covered in the "fundamentals" would be pertinent. The solution peculiarities of the alkaloids and their salts could be presented with significant referral to aqueous and oleaginous vehicles previously considered in the "preparations" course.

The integration between pharmacognosy and pharmacology has been mentioned previously. A course in toxicology, if offered, should be included in this consideration. Without coordination between the instruction in these three subjects, much time could be wastefully spent on the same information. A limited amount of overlap might be desirable, but it would be inexcusable on the part of the pharmacognosist to discuss the complete physiological action of the drug or on the part of the pharmacologist to discuss the full pathological effects of overdosage with the drug if these are to be covered by subsequent instruction.

In the study of public health, which field is ever expanding as an avenue of professional service for the pharmacist, integration of natural product in-

formation may result in increased meaning for the student. He can better understand the solution of some of the problems confronting today's public health workers if he is given a correlation of the amount of a natural product, for example a blood constituent, available from a laboratory animal as compared with the amount needed to treat a single patient or combat an entire epidemic. A reference to the mass employment of antibiotics and other anti-infective agents, currently proposed in civil defense and disaster planning, likewise increases the value of such integration efforts for the student of public health.

Very interesting human nature correlations between natural products study and the course in jurisprudence may be found in legal case reports and commentaries available in the pages of numerous pharmacy journals, news sheets, Food and Drug Administration reports and recent textbooks. The value of both courses to the student is thus enhanced.

The integration of natural product study with the subjects offered under pharmacy administration is an interesting problem, for in this area can be found the most important justification for the inclusion of natural product study in the professional curriculum. Some course in this division of pharmacy instruction will be found to cover the principles of salesmanship, since the business aspects of the profession demand such in the pharmacist. Every discourse on the subject of salesmanship emphasizes the importance of product knowledge. Without conversant knowledge of the properties of drugs which occur in the preparations sought by the customer or prescribed by the physician, the pharmacist is prepared to sell neither his goods to the customer nor himself, as a drug specialist, to the physician. Consequently, the subject matter of pharmacognosy, no matter under what title it may be learned, is of vital importance to both the purse and the prestige of every practicing pharmacist.

In conclusion, the statement may be made that although each of us who teaches in the field of natural products has already employed a number of the practices recommended by papers on the subject of integration, few of us can say honestly that we have employed all of them or enough of them. Wherever these suggestions are applicable to the local situation, we may do well to try them all for the improvement of our teaching in the field of natural products.

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The Learning and Proper Use of Scientific Vocabulary Related to Products of Biological Origin

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The importance of an adequate scientific vocabulary is recognized by everyone connected with the teaching of pharmacy students. No student or teacher can possibly attain or possess a proper understanding of a subject without mastering a vocabulary appropriate to that subject. One cannot imagine a student having much of an idea of the life processes of plants unless that student has an understanding of such terms as osmosis, translocation, respiration, and many others.

Certainly we all agree that vocabulary words must be learned and understood. The main reasons for this might be stated as follows. First, because an adequate vocabulary is essential to the understanding of the subject matter of the course in which it is acquired. General zoology has its own collection of terms and phrases as do general botany and entomology among other subjects. Secondly, many new words and phrases whose meanings are learned in one course are used in other courses. Such elements of a vocabulary serve as connecting links between the subject matter of different courses. Of the technical terms used in pharmacognosy many are learned in the beginning courses in zoology and botany as well as in other courses. Students commonly encounter and learn the meanings of various therapeutic terms such as mydriatic, anthelmintic, carminative, and many others during their study of pharmacognosy. Later this knowledge can be and is used by the student in his study of pharmacology. Numerous additional examples could be mentioned. Thirdly, the student's use of a scientific vocabulary does not end with the terminating of his formal education. The importance of an adequate understanding of technical terms by the pharmacist is becoming more and more evident as each year passes. The pharmacist is being looked upon with increasing frequency by the physician and others as the source of a great deal of advice concerning medicinal and other pharmaceutical materials and pesticides. One has only to examine manufacturers' brochures dealing with medicinal and pesticidal products to see how important an understanding of technical vocabulary really is. The pharmacist cannot hope to take his proper position as a trained individual unless he does possess an adequate understanding of scientific terminology. A professional vocabulary is a great professional asset and it has much to do with increasing the effectiveness of one's speech. The student will do well to avail himself of the opportunity that he has to improve his range of language in such courses as pharmacognosy, physiology, pharmacology, and bacteriology, as well as in others. It is up to the teacher to see that this is done.

As has been stated earlier, it is generally agreed by teachers that vocabulary words must be learned and understood. Any disagreement seems to be concerned with the number of new vocabulary words that students have to learn in a course and the way they are to learn them.

The learning of a vocabulary should begin early in any course and should be a gradual process. However, the teacher has to be careful that this type of work

is not overdone. There are probably few situations that are more likely to discourage beginning students than having to learn almost endless numbers of technical terms and their definitions.

What then is the teacher to do about this phase of teaching? It is a matter concerning which there is much disagreement and each teacher may find it advantageous to handle it in his own way. However, he will need the help of others. The individual student's pre-college training may have a great deal to do with the ease with which he learns technical terms, their meanings, and the ways in which they are spelled. Unfortunately not all students have equally good high school backgrounds. No matter how much we say or do about learning the elements of a technical vocabulary this task is a difficult one at best. Teaching someone how to learn them is no easier. The number of terms is endless and this condition constitutes only one of the basic difficulties.

Another basic difficulty is that the words of a technical vocabulary are commonly derived from Greek and Latin roots, and the connection between the roots and the terms themselves is sometimes rather difficult to see. Today few teachers and still fewer students in the schools of America have had any formal training in the Greek language. Training in this language is perhaps confined to some knowledge of the Greek alphabet or more often to the letters of a particular student's fraternity insignia. Limited familiarity with Latin is possessed by a somewhat larger group of teachers and students.

One should not expect a first year pharmacy student to possess any degree of intimacy with a scientific vocabulary. However, one can only hope that the student has received some instruction in the origin of words during his high school training in English and/or certain other subjects.

The teaching of such a vocabulary as related to products of biological origin to students of pharmacy should begin in freshman English and in the basic science courses. The help of the English teacher is very important here. Without his help the teachers of the science courses are likely to face considerable difficulty. However, one must not leave this entire task to the teacher of English. This undertaking is difficult and must be carried out as a cooperative one. Learning the origins of technical terms is extremely important to a proper comprehension of the vocabulary of any branch of science.

Unfortunately there is a tendency for opposition to arise in the minds of the students in English courses just as soon as the teaching of technical terms is undertaken. This is one of the difficulties with which the English teacher has to contend. He must try to impress the student with the importance of this phase of learning. At the same time the teachers of the science courses should be doing their part with the student in vocabulary building. The teacher of English can help a great deal by having his students learn a number of Greek and Latin root forms. Pure memorization will have to be resorted to here.

He should assign a number of the root forms each period and explain these thoroughly to the students. Explanation is very important here. At a later period the students should be given practice in spelling, pronouncing, and

defining the terms of the assignment. The following might be considered as a sample lesson. These are typical of the combining forms that are essential to any sort of an understanding of the etymology of a biological vocabulary.

Prefixes	Suffixes
A, Ab - away from, not	-algia - pain
Bi - two	-cyte - cell
Broncho - bronchus	-oid - resembling
Cata - down	-ology - study
Chloro - green	-phyte - plant
Chromo - color	-rhea - flow
Ecto - without, on the outside	-soma - body
Hetero - other	-taxy - arrangement

A thorough introduction to these and other terms during the study of English will pay dividends later. Assignments should be made frequently. Unless the student has an understanding of such terms he will find it very difficult to build up an adequate vocabulary.

A large part of a technical vocabulary is formed with the aid of prefixes and suffixes such as those included in the above list. It hardly seems necessary for one to again mention the importance of having students memorize the meanings of selected Greek and Latin combining forms. Unless the student does familiarize himself with a goodly number of these root forms he will find himself faced with the almost impossible task of learning the meanings of scientific terms parrot-fashion.

Teachers of English can also help by requiring their students to learn certain selected Latinized adjectives used as specific epithets in the scientific names of plants and animals. Meaning, pronunciation, and spelling all are important here. Other commonly mispronounced and misspelled words should certainly be assigned to beginning students in English. Among these are sarsaparilla, glycyrrhiza, diarrhea, and hemorrhage. The singular and plural forms of some nouns are troublesome, and their spellings should be emphasized. Some of these are medium and media, bacillus and bacilli, coccus and cocci, ovum and ova, as well as numerous others.

As has been stated earlier the English teacher should not be expected to carry this load alone. The job of showing students the importance of learning a scientific vocabulary as well as how to use it properly must be a cooperative one, one in which the teachers of different subjects work together toward a common goal.

Hough, in his excellent book entitled Scientific Terminology, states that " scientific terminology may be divided into five general types, each of which has its own characteristics and for each of which slightly different sets of linguistic skills, as well as somewhat different kinds of vocabulary, are necessary." The five types are (1) technical English words; (2) Greek and Latin phrases; (3) pharmaceutical terminology; (4) Linnaean nomenclature; and (5) reading and writing Latin descriptions. During his formal education the

undergraduate student of pharmacy will encounter, to a greater or lesser extent, all but the last of these types.

In view of the tremendous number of new and strange terms that the student must learn during his training a limit must be set somewhere. In various courses dealing with the subject of biology the student encounters many bewildering terms even before the first class period is completed. The question of how much stress should be put on terminology always arises. Of course, only the teacher can make the decision in a case like this and it must be a rather arbitrary one at best.

The handing out of long lists of technical terms for memorizing by the students in a biology course is one of the surest ways of bringing about discouragement. The importance of acquiring an adequate command of the language is recognized, but making " walking dictionaries" out of students is not one of the objectives of any course in biology. Terms are not to be taught as terms but as integral parts of the subject matter. This is especially important in the basic natural science courses.

In didactic work the teacher' s discussions or lectures should include careful explanations of as many necessary terms as time permits. Whenever possible illustrative material should be employed. This can consist of actual biological materials, models, charts or blackboard sketches. As an example, when the teacher lectures to general botany students concerning bacteria he will find it advantageous to have a variety of bacterial cultures among the demonstration items available. During the discussion these items should be passed among the students. At such a time the teacher is afforded a fine opportunity to introduce and explain such terms as bacterial colony, culture medium, chromogenic bacteria, Petri dish, and various others. Learned in this manner terms are bound to be retained in the minds of the students.

Models representing enlargements of certain plant or animal parts are sometimes more useful than actual materials. Flower and fruit models which are made to be dismantled are especially useful when explaining terms which apply to these structures. Teaching aids of this type are highly valuable for illustrating the meanings of such terms as sepal, petal, calyx, corolla, pistil, pericarp, and many others.

Charts of many types representing a variety of materials have their place in aiding the student to master the problem of terminology. However, their value is perhaps overestimated at times. Some teachers make little or no use of this kind of auxiliary item, claiming that too many gaudily colored charts detract from what the lecturer is saying. Whether or not this is true would be difficult to prove, however. Other teachers use large numbers of charts. Probably it is best for the teacher to make judicious use of a moderate number of carefully selected charts rather than going to either extreme. It is important, however, that one keep in mind that charts are of limited use in didactic phases of teaching.

This writer believes that blackboard sketches are of great value when ex-

plaining scientific terms. The teacher need not be an artist to prepare neat and accurate diagrams or drawings when lecturing or explaining various phases of work. This practice serves to keep the students' attention directed to the subject being considered. In beginning courses the use of blackboard sketches is especially important. The teacher is also urged to emphasize repeatedly the need of correct pronunciation and spelling.

Consideration of terms during lecture or discussion periods is not enough. Laboratory material should always be selected with the thought in mind that it will illustrate particular points that need further emphasizing. This practice lends itself nicely to being used in biology courses in general. As an example of such material, one might mention the use of a variety of leaf forms in general botany laboratory work. The preparation of neat sketches by the student aids him in learning the meanings of selected terms applied to leaf morphology, especially those referring to apices, bases, margins, and outlines. Some consideration is always given to the study of fruit types during laboratory work in the course in botany. At this time the use of a variety of fresh and preserved materials will be found to be worthwhile. It seems best that selected terms applied to the material at hand should already have been discussed and explained in an earlier lecture period. Some of the terms that an exercise on fruit helps to fix in the student's mind are berry, capsule, and achene, as well as other words employed in designating fruit types. Words such as pericarp, suture, valve, dissepiment, and loculus are also readily learned here.

Throughout the courses in biological sciences the teacher will find it possible to select laboratory materials the study of which will aid the student in learning portions of a technical vocabulary. These materials should be used in conjunction with models, blackboard sketches, and charts, and their study should be accompanied by appropriate explanations by the instructor as well as by use of laboratory manual, textbook, and lecture notes.

Little has been said in this paper concerning the learning of scientific names of plant and animal species. However, it is well recognized that a certain number must be learned by the pharmacy student. The significance of scientific nomenclature should be explained to students in the beginning courses in biology and some practice in its use should be given at that time. If the student has already learned, in English courses, the meanings of certain terms used in the naming of species the significance of these designations will be more quickly apparent.

Students should have a thorough familiarity with the words used in designating various categories in plant and animal classification. This is especially true of the words family, genus, and species. These terms are frequently used in some courses and it should not be necessary for the teacher to define or to explain them repeatedly. Other category designations as division, phylum, class, order, and variety are encountered by the student but are probably used less frequently than the three named previously.

While the extent to which students are required to learn the scientific names of plants and animals is a matter for the individual teacher to decide there are certain fundamentals of nomenclature that must be learned by the pharmacy students. The usual endings of family names, the fact that generic names are

always capitalized, and that specific epithets are usually adjectives are among the points that the teacher should bring to the mind of the student. Of course, this is an over-simplification of the principles of biological nomenclature.

A thorough understanding of the meanings of therapeutic terms is essential to the pharmacy student and to the graduate. The meanings of these terms should be learned as early in the curriculum as possible, at least by the time that the student has to learn any drug uses. The terms can be assigned a few at a time, and learning them will not be found burdensome if the student has received earlier instruction in word origin as recommended in this paper. Learning one or more examples of drugs that represent each therapeutic class is sometimes required of students.

There seems to be no end to the learning of a scientific vocabulary related to natural products. Of course many of the terms are learned, in part, in other than the biology courses. In chemistry and pharmacy courses the student learns many of the terms applied to materials of plant and animal origin. These terms are too well known to require discussing here.

At one time it was necessary to require students to learn long lists of so-called synonyms of crude drugs, preparations, etc. There is much less need for this today and the teacher will do well to revise his requirements on this matter frequently. Probably there is justification for requiring students to learn official synonyms of certain drugs, preparations, and derivatives. In some cases and in particular geographical areas there may be need for including unofficial drugs. The teacher can often help by explaining the significance of these common names to students. Bitter root, goldthread, scullcap, and henbane are a few examples that lend themselves to such a discussion. Admittedly the particular common names (synonyms) and the specific drugs and preparations that are in use will vary from one section of the country to another. Consequently each teacher must make his own selections when deciding what names and drugs to include for presentation to the students.

In this paper an effort has been made to discuss some of the problems connected with the learning and proper use of a scientific vocabulary pertaining to products of biological origin. The reasons why this type of knowledge is important are included, as are recommendations concerning cooperation between the teachers of English and the courses in science. The last part of the paper consists of a series of suggestions on what can and should be done to assist the student in learning a technical vocabulary.

No claim is made that this consideration of the subject is a complete one by any means. However, it is hoped that what has been included will stimulate further thought and discussion of this very important phase of learning.

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Section C - BASIC PREREQUISITES

for

PHARMACOGNOSY

Botany as a Basic Prerequisite for Undergraduate Pharmacognosy

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It obviously is not necessary to justify the inclusion of botany in the pharmaceutical curriculum, for it is now generally recognized that a thorough training in the biological sciences is basic to the practice of pharmacy. The inclusion in the curriculum of new subjects of a biological nature, new drugs of natural origin, trends in educational thinking, and tradition have in part been responsible for the continued offering of botany in the curriculum.

Although botany is accepted as one of the basic prerequisites to instruction in pharmacognosy, this fact should not be the sole determinant of the objectives and content of the course. Botany should not be tailored primarily as a background course for pharmacognosy but should include a study of biological principles, and of the structure and physiology of plants.

The Pharmaceutical Curriculum by Blauch and Webster includes two four-year curricula in pharmacy. (1) These suggested courses of study are organized respectively on the semester and quarter plan. In the semester plan, general biology is a course of eight semester hours and is offered in the first year. In the quarter plan a course in zoology equivalent to six semester hours is offered in the first year, with botany and pharmacognosy listed together in the junior year for a total of an equivalent of eight semester hours credit. The objectives of the botany course are not stated, and the basis for inclusion of the course in the third year is not indicated.

The writer in a recent survey of the curricula of seventy colleges of pharmacy noted that botany and zoology are offered as separate courses in the majority of the schools. Approximately three-fourths of the schools offered botany, whereas only one-sixth included general biology. Specifically, a botany course of four semester hours included in the first year and consisting of thirty-two clock hours of didactic instruction and sixty-four clock hours of laboratory instruction was most common. Zoology was offered in the majority of the schools and comprised a course of four semester hours given in the first year.

General biology, purportedly a combination of equal parts of botany and zoology, is often a diluted course with disproportinate amounts of time devoted to the constituent courses. That botany may receive the minor portion of attention in the general biology course is indicated by a review of one of the well known general biology texts. Contrary to the author's claim of a "balance between the botanical and zoological portions" (2), approximately one-third of the suggested course is devoted to botany and two-thirds to zoology. This is felt by some to be an inadequate treatment of botany.

As was indicated earlier, botany should include a study of biological

principles and of the structure and physiology of plants. In line with this thinking some of the more important objectives are listed in Table I. The content of the lecture portion of a course of four semester hours is shown in Table 2. It is obvious from a study of the latter table that some subjects will require two or more lecture periods, whereas other subjects will require less than one lecture period. A laboratory schedule has not been included since the content of the laboratory course generally parallels that of the lecture.

The laboratory course at our college includes living and preserved plant specimens, permanent mounts of plant tissues, audio and visual aids, and student projects. Each student receives a laboratory manual including plates and experiments to be completed during the laboratory period and returned to the instructor.

The following includes a detailed description of audio-visual aids and student projects:

1. Audio and Visual Aids. -- The microprojector, 16 mm. and 35 mm. projectors, and lantern slide projector are used in the laboratory.

The microprojector is a valuable instructional aid in the study of sections of algae, fungi, roots, stems, leaves, and other plant material. The fact that living or preserved material may be used in place of drawings or diagrams makes for a more effective presentation. With this aid it is possible to work with groups of fifteen or more students, thus conserving valuable instructional time. The microprojector, however, does not replace individual student study of laboratory material.

Numerous sound films and film strips are available on a free or rental basis from universities, industry, governmental agencies, and commercial organizations. It is our experience that audio-visual aids of this type stimulate student interest and provide an effective method of presentation.

The lantern slide projector is used for demonstration of material not easily adapted to or covered by the previously described aids.

2. Student Projects. -- At the beginning of the semester the students are informed of the required project or term paper. A list of suggested topics is made available. The student may select his own project or topic, and may work alone or with a group. Oral reports are presented to the class upon completion of the project. Several experiments relating to photosynthesis, osmosis, etc. are available in undergraduate general physiology manuals.

TABLE I

General Botany - Objectives

1. Importance of plants to man
2. Nature of plant cells and tissues and their arrangement in plant organs
3. Nature of cellular inclusions
4. Understanding of the physiological processes of plants
5. Functions of plant parts
6. Basis of classification of plants
7. Survey of the plant kingdom
8. Nature of mitosis, meiosis, reproduction, and growth
9. Effect of environment on plant growth and distribution
10. An understanding of inheritance and variation in plants

TABLE II

Outline of Botany Lecture Schedule

Subject	Content
Introduction	Scope of course Subdivisions of Botany - morphology, physiology, etc. Plant kingdom divisions Comparison of plants and animals
The Plant Cell	Composition and nature of protoplasm The cell wall Protoplasmic cell contents and inclusions Types of cells and their functions
Osmosis	Diffusion, permeability, and turgor Brownian Movement Tonicity and significance
Mitosis	Significance of cell division Nuclear functions Four phases of mitosis Regions of mitotic activity Other methods of cell division
The Root	Functions and types of roots Regions of root - cap, embryonic, elongation, etc. Meristematic tissues - root tip, cambium, etc. Root histology - monocotyledon and dicotyledon
The Stem	Functions and types of stems Regions of stem - embryonic, elongation, etc. Meristematic tissues - stem tip, cambium, etc. Stem histology - monocotyledon and dicotyledon - animal ring formation - lenticel formation and function
The Leaf	Functions - photosynthesis, transpiration, etc. Types of leaves - foliage, scale, etc. - deciduous and evergreen Forms of leaves - simple and compound - leaf parts, including lamina, margin, etc. - venation types Leaf histology - epidermal, palisade, etc. - guard cells and stomata - plastid type and function

TABLE II (contd)

Basic Physiological Processes	Photosynthesis	- raw materials, pigments, conditions and products formed - energy relationships
	Respiration	- raw materials, conditions and products formed - Aerobic and anaerobic - comparison photosynthesis and respiration
	Transpiration	- functions and mechanics - factors affecting rate of water loss
	Metabolism	- anabolism, catabolism and assimilation - enzymes - nature and function - autotrophs and heterotrophs
Plant Classification		Basis of classification Significance and origin of species, genera, families, etc. Synonyms - origin and usage
Blue-green Algae		General characteristics and distribution Structure and reproduction of Gleocapsa and Oscillatoria
Meiosis		Significance of reduction division Stages of meiosis Meiosis and mitosis compared
Green Algae		General characteristics and distribution Structure and reproduction of Protococcus, Spirogyra and Oedogonium
Brown Algae		General characteristics, distribution and economic importance Structure and reproduction of Fucus
Red Algae		General characteristics and distribution Source of Agar and Chondrus
Diatoms		General characteristics, distribution and economic uses
Bacteria		General characteristics and distribution Economic importance - industry, nitrogen fixation, decay and disease
Phycomycetes		General characteristics and distribution Structure and reproduction of Rhizopus

TABLE II (contd)

Ascomycetes	Nature and distribution Structure, reproduction, and economic importance of yeast, penicillium, aspergillus and ergot
Basidiomycetes	Nature and distribution Structure, reproduction and economic importance of wheat rust and mushrooms Smuts and rusts
Lichens	Nature and distribution Structure, reproduction and use of lichen products in pharmacy
Bryophytes	General characteristics and distribution Structure and life cycle of Polytrichum Comparison of bryophytes and thallophytes
Pteridophytes	General characteristics and distribution of ferns, horsetails and club mosses Structure and life cycle of the brake fern Comparison of ferns with horsetails and club mosses Aspidium and lycopodium in pharmacy Comparison of pteridophytes and bryophytes
Spermatophytes (gymnosperms)	General characteristics and distribution of the gymnosperms Structure and life cycle of the Pine Products of economic importance Comparison of gymnosperms and pteridophytes
Spermatophytes (angiosperms)	General characteristics and distribution of the angiosperms The flower - structure and functions Life cycle of an angiosperm Medicines, foods and other items of economic importance Comparison of angiosperms and gymnosperms
Seeds and Fruits	Types and structures
Genetics	Mendel and his experiments Characters, chromosomes, genes, etc. Economic implications

SUMMARY

1. The content of a botany course of four semester hours is presented.

2. Botany should be taught as a separate course and not as a constituent of general biology.

3. A recent survey by the author of the curricula of seventy colleges of pharmacy and recommendations of The Pharmaceutical Curriculum with respect to botany and general biology are discussed.

4. The value of audio-visual aids and of student projects in stimulating student interest is discussed.

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Zoology as a Basic Prerequisite for Undergraduate Pharmacognosy

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Perhaps it is fortunate that one like myself, totally ignorant or nearly so with reference to the field of pharmacognosy, but trained in zoology, be asked to speak to you with reference to the values of zoology for the undergraduate student in your field. It is axiomatic that persons engrossed in one extreme speciality are frequently in a position where they cannot see the trees for the forest. Being perfectly cognizant of my position, I only hope that in setting forth the values of zoology, as I see them, that I will not be like the old model T Ford, in which every time the horn was blown its lights went out.

After being asked by Dean Hiner to take on this responsibility, I attempted to find out first what pharmacognosy was and is, and what part in the curriculum the discipline of zoology played. Reference to the dictionary informed me that pharmacognosy was the science of drugs, primarily those of plant or animal origin. I then tried to inform myself by means of the catalogues of the various schools of pharmacy, on what part zoology had in the training of specialists in pharmacognosy and in the entire curriculum of pharmacy. Permit me to say that I was dismayed at the dearth of courses required or even suggested. In some, I found only some very general requirement of beginning biology. In others no courses of zoology as such, and in still others, no courses in the first two years, and only two mentioned at all, and these apparently only under specific conditions and dependent upon rather careful scrutiny and supervision. To me this came as rather a shock, because I, and I am sure there are others, have always considered pharmacy as one of the fields which is definitely allied to the biological sciences. Maybe I am old fashioned, but a pharmacist to me is still a professional and not merely a purveyor of sandwiches. This realization of the dearth of training of zoology has caused me to formulate some rather definite positions, which I will set forth in the remainder of this paper, and hope that they will prove to be beneficial.

As I see it, this problem can be resolved on two levels: First, what is the actual worth of zoology in pharmacognosy, and second, what are the intangibles that are of definite worth.

In the majority of the catalogues, among others the following objectives are listed " to encourage original work and research among students which will lead to new discoveries in the interests of all medical sciences, and to promote professional relationships among all health groups." The foregoing statement is a commitment that the primary purposes and dedication of the science is totally one concerning mankind and his wellbeing. Scrutiny of the curricula of the other medical sciences, and those related to them, indicates that they all require considerable course work in the field of zoology. The position of pharmacy in general, and pharmacognosy in particular, is incongruous in light of the foregoing. Usually some formal work in botany is required in

pharmacognosy, and this makes good sense, inasmuch as the science of pharmacognosy is greatly concerned with plants and plant products. We laymen know, however, that many drugs are of animal origin, and yet little, or no formal study in zoology is required. What is the thinking that requires courses in botany for pharmacognosy as basic to a knowledge of drugs of plant derivation, and yet requires no basic courses in zoology as background for the correct interpretation and understanding of those of animal origin? Biologists are all aware of the fact that plants, even the most complicated of them, are relatively simple organisms as compared to animals. Are students of pharmacognosy supposed to attempt to interpret animal structure and function as concerns the drugs in which they are interested in the same terms as those applicable to plants and their products? The structure and function of plant cells, tissues and organs little resemble those of animals, and even the intimate chemistry of the development of the drugs is probably remarkably dissimilar. So much for these aforementioned conditions, but the greatest incongruity of all, to the zoologists, is the fact that by their own admission, the pharmacists are dedicated to the welfare of man who is an animal about which they have had little, or no formal training.

I hope that you will not consider the aforementioned statements as being too critical. Lest I be remiss, permit me to commend this body for their interest and realization of the problem before us. The mere inclusion of this paper on your program indicates that you realize that a problem exists and that you are interested in resolving it.

From a zoologist's point of view, it would be advantageous for an undergraduate student of pharmacognosy to have a course in invertebrate zoology, and another in vertebrate zoology. In addition, I would strongly recommend a course in comparative vertebrate anatomy for those students who anticipate graduate studies in this field. My reasons for recommending these courses are as follows:

Invertebrate Zoology: Reference to the textbooks of pharmacognosy indicate that considerable information is contained therein relative to invertebrate animals. Moreover, I assume that much of the information dealing with the drugs themselves presupposes at least an adequate body of information with reference to these lower animals. In Youngken's textbook, there are treatments dealing with 5 phyla, 5 classes, 3 orders, 3 families and many genera and species of invertebrate animals. The material in this reference book is markedly condensed, and an undergraduate student without sufficient training in invertebrate zoology would be certainly handicapped in this phase of his use of this textbook, and in his understanding of the significant facts that bear upon the place of invertebrates in pharmacognosy. It is therefore evident, that some training in this subject matter is necessary. I appreciate that these textbooks are written for a specific purpose, but why then are they padded with considerable descriptive material of both an anatomical and physiological nature if the student has had insufficient training to properly understand them. It would appear, that Youngken at least, has taken for granted that his readers are based in the subject matter of invertebrate zoology.

A second reason for requiring a course in invertebrate zoology would be to train the student in the basic structure of simple animal cells, upon which he

could then build a background of the structure and function of simple animal tissues and organs. Upon this basic material could be expanded and developed the knowledge of the principles of the increase in complexity of structure and function and the division of labor as animals ascend their phylogenetic tree. Certainly a knowledge of the incipience of the tissues and organs that are later to form the drugs in which he will become interested, should be extremely valuable to a student of pharmacognosy.

An extremely interesting and important group of invertebrate animals is ommitted entirely from textbooks of pharmacognosy, and are little dealt with, as a matter of fact, even in the medical training. These are the members of the phyla Platyhelminthes and Nemathelminthes. Both of these phyla contain many animals that are parasitic internally in man. These animals, therefore, are of considerable economic importance. As a group, the members of these phyla have probably the most complicated life histories of any animals. Their method of entry into the human body and its symptoms, the ravages which occur at the different periods of their life histories should be part of the training of students of pharmacognosy. They should be trained not only in the drugs of control, but in their proper administration with reference to the various stages within the life cycles of these animals. Perhaps one of the oldest remedies that pharmacists have dispensed has been some type of vermifuge, and in my experience, these men do considerable recommending, particularly in the smaller communities. Personally, I think it goes without comment that these pharmacists would be better qualified with some training in this material.

While textbooks of pharmacognosy devote considerable space to the class Insecta of the phylum Arthropoda, some great voids are evident. I was unable to find any mention of insects and disease, insects and health or any reference to the control of insects. This should be important in pharmacognosy, because I am certain that many pharmacists are asked what insecticide should be used in the control of certain insects. Many compounds are on the shelves, and some of them are dangerous in the wrong hands. In pharmacognosy would it not be an advantageous place to train these future pharmacists in this phase of zoology? Many additional arguments could be set forth to support the proposition that a course of invertebrate zoology should be an integral part of the curriculum of pharmacognosists, but the above are sufficient to indicate its values.

Vertebrate Zoology: A substantial course in vertebrate zoology is needed in the undergraduate curriculum of pharmacognosy. A casual perusal of the introduction to the phylum Chordata in the reference sources of pharmacognosy leaves the reader with some doubt as to whether or not he has been reading a textbook in vertebrate zoology. The characteristics of the animals that are set forth and the terminology employed for them are strictly zoological. Zoological classification is used throughout, and the best usage down to the genera and species is employed and is in strict keeping with the "binomial nomenclature" and the rules as established by the International Zoological Commission. Apparently, students of pharmacognosy are exposed to, but not trained in every class of vertebrates, except one. I did not note any reference, in the literature available to me, that dealt with the class of the amphibians. Being a zoologist, I was pleased to learn of the amount and type of information

relative to vertebrate zoology in the literature of pharmacognosy. By the same token, I wonder of what value this information is to a student of this subject who is not trained in vertebrate zoology. Students of pharmacognosy are supposed to apparently learn the organs of vertebrates that produce vitamins, hormones, enzymes, sera, etc. Not only are they supposed to know the organ grossly, but they are likewise supposed to master the microscopical anatomy. Every organ of vertebrates that had bearing upon the subject of pharmacognosy was thoroughly dealt with. Permit me to quote a little from the textbook by Youngken to bring out my point. " The thyroid is a ductless, compound tubular gland and consists of two large almond-shaped lateral lobes united by a narrow band, the middle lobe or isthmus, and forming a projection on the ventral surface of the trachea. The thyroid is surrounded by a capsule of dense, white fibrous connective tissue that sends in trabeculae which divide the gland into lobes and lobules. The lobules are composed of a number of short, closed tubules or follicles. Each of these follicles is lined by cuboidal epithelium that rests upon a basement membrane. Outside of this is connective tissue which supports blood vessels and lymphatics. The lumen of each follicle contains colloidal material or colloid which is formed by the epithelial cells." Following this description of the gross gland, there is a paragraph on the detailed histological characteristics of the gland. You should thank me for not choosing the adrenal or the pituitary gland. The latter alone consists of four pages of detailed description that would do any textbook of zoology proud. I think the above quotation just about makes it mandatory that vertebrate zoology be included in the students' undergraduate curriculum. Where are they supposed to learn this detailed terminology and these refinements of the gross and microscopical anatomy? The pharmacognosists themselves, by their writing, have demanded a knowledge of vertebrate zoology from these students, and being a zoologist, and primarily a vertebrate zoologist, it escapes me why this subject is not required at the undergraduate level of their training. Now do not misunderstand me, I do not wish to infer that the students be trained only that they might read the literature in their own field. In addition, there are many values, culturally and otherwise to be acquired in gaining a knowledge of animals. I am constantly confronted, however, with the thought of how much more valuable and meaningful their training would be if it were solidly based upon a course in vertebrate zoology.

Comparative Vertebrate Anatomy: I know that previously here at the University of Utah, this course was taken by students in the School of Pharmacy, but it has long since ceased to be required. It is appreciated that students of pharmacy operate on a rather close schedule, and I should not like to give the impression that this course is basic for all types of students. The majority of students will not need this detailed type of instruction, but the occasional student might profit by it. If a teacher discovered a student of promise for graduate work in pharmacognosy, then this subject should be extremely valuable at the undergraduate level. This course would familiarize the student not only with the actual overall anatomy of representative vertebrates, but would afford him the opportunity to actually dissect and study those organs which are directly the concern of pharmacognosy. Do you not agree that it would be advantageous for a student to have a thorough knowledge of the progressive increase in complexity of such organs as the thyroid, pituitary, adrenals, gonads, etc.? These are structures that produce many of the compounds with which he will be concerning

himself. Certainly a good knowledge of the details of the vascular system should prove to be helpful to the student who will later become interested in the production of the various sera. Comparative vertebrate anatomy and also possibly another course in animal life histories and behavior would be helpful to students who plan to do research involving the use of laboratory animals. Not only would such students be more successful in rearing and caring for their animals, but they would have firsthand knowledge of the animal structures from which pharmaceuticals are derived. Equally important, they would likewise know the other structures upon which the developed drugs exerted their influence.

In the foregoing sections of this paper, I have attempted to set forth the tangible values of training in zoology for students of pharmacognosy at the undergraduate level. We are all aware also that many intangible values exist in this field for these students.

It is not incorrect to think of pharmacognosists as biologists, because the very nature of their training and its usages is one phase of applied biology. Being biologists whose main training is to benefit mankind, they are primarily zoologists. Formal courses in zoology, such as those mentioned above, do provide some extremely valuable disciplines and scientific approaches to all problems. Leaving aside here, for our immediate purposes, the many cultural values that students of pharmacognosy might obtain in their courses of zoology, permit me to confine my remarks to some more real values.

Training in zoology is one of the richest fields in which to develop and experience a genuine scientific curosity. Perhaps this results from the very nature of the material itself. As one fact is learned, it invariably leads to others, and this arouses a real curiosity to learn the why, the how and what are the final results. This leads to real inductive reasoning. Coupled with this, we find an increasing development of clear, concise thinking in keeping with the scientific attitude. This curiosity leads to a careful selection and evaluation of the facts. Remarkably soon, under this discipline, a true religion for the sanctity of the facts is developed. Emotional approaches to problems give way to this careful alignment of the data, and the logical development of the proposition. Students quickly learn that science is impersonal, and that science is held down by the stubborn, irreducible facts. In learning to reason and think from the facts, they develop an attitude toward all problems and their resolution, that will benefit them no matter what their future field of specialization may be. None of us would deny that a real training in the scientific attitude, with its training in straight, logical thinking is one of the greatest acquisitions that a student of any subject could acquire.

After having developed a healthy curiosity and an intense devotion to the scientific attitude, next comes their utilization in a practical manner within the framework of the scientific method. Step by step, the mastery of the careful compilation of the facts, followed by the emergence of an hypothesis, further subjection to verification, and the final emergence of a true principle is a great thrill for a student, and one which will thereafter be his modus operandi for life. If only these values could be obtained by students of pharmacognosy by studying zoology, the training would be invaluable. We as educators must never lose

signt of the basic truth that the greatest contribution we can make to a student is to train him to think, and to constantly remind ourselves that we are committed to develop good, straight thinking citizens as well as outstanding specialists.

In conclusion, may I summarize my position with reference to basic zoological courses as requirements in the undergraduate discipline of pharmacognosy. Basic zoology courses should be required because:

1. Pharmacognosy deals in part with animals and their products. Although animal derivatives are less in number than are those of botanical derivation, they are, nonetheless, extremely important.

2. Students require certain basic zoological information in order to understand their own subject and its ramifications.

3. With the ever expanding horizon of the subject of pharmacognosy, the student can only progress in direct ratio to his basic training. The addition of new facts to those already poorly understood and arranged, can only lead to chaos.

4. Zoological training is excellent for developing independent thinking in keeping with the scientific attitude and the scientific method.

5. Zoology makes a remarkable contribution to the cultural development of students.

General Biology as a Basic Prerequisite for Undergraduate Pharmacognosy

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The topic I have been asked to discuss appears to have two facets: (1) what general biological knowledge and skills are needed by undergraduate students before they begin the study of pharmacognosy, and (2) what course or courses in biology can best provide these knowledge and skills.

We cannot determine the nature of the prerequisites unless we first know what the objectives and approach are for the undergraduate courses in pharmacognosy. So a third question is also involved: what do we aim to do in undergraduate pharmacognosy, how are we going to present the course, and what outcomes do we expect? These matters were presented during the earlier sessions of the Seminar.

The discussions of yesterday were not known in detail when this paper was written. I did know the points of view of several of the speakers and have no intention of repeating their opinions on the objectives of the undergraduate courses in pharmacognosy. I do wish to emphasize that if these objectives are to be accomplished within the time ordinarily allotted to pharmacognosy, the student must come to the course with a good general understanding of plant and animal biology.

Regardless of the degree of emphasis, the system of classification, or the general approach, practically all courses in pharmacognosy include consideration of:

1. Gross parts of plants and animals used as sources of drugs.
2. Botanical, and to a lesser extent zoological taxonomy of the organisms from which these parts are obtained.
3. Scientific and common botanical and zoological nomenclature.
4. Cellular constituents of medicinal and pharmaceutical value.
5. Microscopic characteristics of cell constituents, cells, tissues, organs, and organ aggregates.
6. Therapeutic use, with references to tissues, organs, and organ systems of man and of other animal s.
7. Commercial production of drug plants and animals, with reference to climatic and other environmental conditions.

In addition, undergraduate courses in pharmacognosy frequently include more specialized topics such as:

8. Aero-allergens, their nature, measurement, and distribution.
9. Control of weeds.
10. Control of insects.
11. Control of rodents.

Laboratory instruction in undergraduate pharmacognosy frequently involves:

1. Recognition of gross structures of various plants and plant parts.
2. Extensive use of the microscope.
3. Simple micro-chemical procedures.

Without question, courses in general botany and in general zoology include instruction useful to an understanding of the various topics enumerated here. Also without question, a substantial course in general biology includes such instruction, I believe in a better integrated fashion and more economically from the standpoint of time required to cover adequately the various topics. The point of view of general biology is also somewhat different than that of the usual course in general botany or in general zoology. Perhaps I can best illustrate these statements by a brief description of a course in general biology that I believe to be satisfactory as a basic prerequisite for undergraduate pharmacognosy.

But first I want to emphasize that the type of course in general biology designed to be a definitive course for the general education of students majoring in such fields as social science, language, music, or literature is not satisfactory, nor is it intended to serve as a prerequisite for pharmacognosy or for any other advanced course in biology. Such courses are common in colleges and universities, and they should not be accepted as adequate preparation for pharmacognosy.

Instead, the course in general biology should be a substantial one including laboratory instruction, and so designed that it gives adequate background for any laboratory course in either botany or zoology that ordinarily requires as prerequisite either a semester of general botany or one of general zoology. Such courses in general biology, one year in duration, are given in many colleges and universities, although they are not so common as are separate courses in botany and in zoology.

The course in general biology should extend throughout an academic year, with two or three hours didactic instruction and six or three hours laboratory instruction. A suitable text is General Biology by James W. Mavor. There are a number of other textbooks that are also satisfactory.

On a semester basis, the first half of the first semester can well be devoted to the morphology and physiology of cells. Here the similarities of protoplasm, cellular structure and cellular activities of plants and of animals can be emphasized, as well as the major distinctions between the two types of organisms at the cellular level.

In learning about cell division - mitosis and meiosis - the student can understand the critical nature of equation and reduction when study of division in plant cells is immediately followed by study of division in animals cells. When introductory botany and zoology are separate courses, cell division is ordinarily presented in each - with little attention to the similarities of mitosis as it occurs in plant cells on the one hand and in animal cells on the other. I

believe the student has a better grasp of the details as well as a better appreciation of the significance of mitosis when the process is emphasized as a biological activity rather than stressing it as a plant cell activity and sometime later as an animal cell one. Likewise for focussing attention on the reductional features of meiosis, topical consideration of meiosis is superior to widely separated discussions of reductional division in the plant cell and then in the animal cell.

Around mid-semester a general discussion of biological classification and nomenclature can well be introduced, preliminary to the separate consideration of plants and of animals to follow. Here again, the similarities with respect to concepts of taxonomic groups, of the species, of the genus, and in scientific naming of plants and animals are of greater significance than are the minutiae of the differences. I believe also that the student has a better appreciation of the principles of classification and of nomenclature from unified treatment as a topic in biology than he gets from consideration of the elements of systemic botany and sometime later an introduction to animal taxonomy.

It is obvious, however, that not every topic is susceptible to unified treatment. While the basic concepts of organization in plants and in animals can be presented simultaneously, details of morphology must be considered for plants and for animals apart from one another, as well as an introduction to representatives of the major taxonomic groups. So the latter part of the first semester can well be devoted to a study of the plant organs, their tissue aggregates, and to a few plants representative of the major taxonomic divisions. Here the life cycles of certain representatives can well be introduced.

The first half of the second semester can profitably be devoted to a corresponding consideration of animal structure and to a few representatives of the major animal phyla. Detailed study and dissection of type forms from every phylum is neither possible nor highly desirable. Familiarity with the chief characteristics of each major phylum, however, is possible and practicable, from study of living and museum specimens, demonstrations, and a limited amount of dissection. I do not believe that detailed knowledge of every segment of the appendages of the lobster is particularly valuable to the pharmacist either from the point of view of general biological education or for inherent usefulness.

During the latter part of the year, return to closely coordinated treatment for plants and animals is feasible. This part of the course can well deal with geographical distribution, ecology, genetics, and organic evolution. And for all of these topics, unified treatment is productive of better understanding of the principles involved than is consideration of these various features in plants apart from animals.

All of the biological principles needed as a general background for pharmacognosy are included in the course in general biology just outlined - those of morphology, physiology, taxonomy, nomenclature, genetics, ecology, and economic features. It is probably not wise to attempt to include in general biology a great deal of instruction specifically designed for pharmacognosy.

For example, in general biology the student will learn the fundamental nature of pollination, but he should not be expected to become well acquainted with many different types of pollen. In the introductory course he should learn considerable about insects but not all of the details needed to understand thoroughly the principles upon which the action of various types of insecticides are based. The course should not become a "pharmaceutical biology" - it should serve as satisfactorily as prerequisite for plant anatomy or for animal histology as for pharmacognosy.

About fifteen years ago a study (1) of biology in our colleges of pharmacy indicated that all curricula included courses in botany and about one-half had courses that included instruction in elementary zoology. Only 11 per cent of the colleges of pharmacy then offered introductory botany and zoology together as a course in biology. Recent study by Blauch and Webster (2) has shown that 80 per cent of the pharmacy colleges now include instruction in elementary zoology, and that in 22 per cent of them introductory botany and zoology are presented as general biology. The past generation has, therefore, seen a marked increase in emphasis on animal biology in the pharmacy curriculum as well as a substantial increase in the number of colleges that present introductory work in the biological field as a unified treatment of plants and animals.

Perhaps I may appear to be naive when I speak of all courses labelled general biology as representing a unified treatment. This is not necessarily true. I know of a so-called general biology course which is largely systematic botany, taught, of course, by a botanist whose research interests lie in taxonomy. I also know of a second introductory course called general biology taught by an enthusiastic ornithologist. As long as the weather remains good in the autumn and as soon as the birds show up in the spring, his course is field ornithology. He does spend the winter months on general biology, but even then he favors animals over plants. Rather than such one-sided courses, pharmacy students would probably be better off with a well-rounded one-semester course in general botany and a second one-semester diversified course in general zoology.

A teacher charged with instruction in general biology intended to serve as prerequisite for advanced biological courses should clearly recognize his obligation to introduce the student to the great biological generalizations, to the principal subdivisions of the biological sciences, and to a significant number of representative organisms both plant and animal. He should also accept the responsibility of presenting the common laboratory techniques of this field of instruction.

Even though one may recognize the logic and the economy of combining introductory zoology and botany into a well-organized substantial laboratory course in general biology, local factors may make the combination difficult. In our colleges which teach their own freshman science courses, the combination can easily be effected if it is deemed desirable. It has been done at a number of such colleges.

Where the college of pharmacy depends upon departments of a university

for service in the basic sciences, the solution may not be so easy. If the university has a laboratory course in general biology, usually eight semester hours credit, acceptable to botany and zoology as prerequisite for sophomore laboratory courses in these sciences, the course is probably satisfactory as a prerequisite for pharmacognosy. However, if the only general biology course offered is the definitive type, designed for students majoring in nonscientific fields, it will not fill the bill. Several universities have just this situation and usually the only solution for pharmacy is to accept zoology and botany separately, as is required for students majoring in one or the other of these fields.

Before concluding I would like to say something concerning a misconception not uncommon among our colleagues who are not biologists. Many years ago a prominent dean of a leading college of pharmacy said to me, " You are a biologist and you teach general biology for one year to freshmen students in pharmacy. My idea of biology is earthworms and frogs, and I cannot understand why a pharmacy freshman needs a year of earthworms and frogs. "

I believe that biology to many non-biologists means zoology and only zoology. And I also believe that many of our colleagues fail to see the importance of introducing pharmacy students early in their college study to cellular biology, with as much emphasis on functional activities as on structural relationships. I know of still other pharmacists who think of biology only in terms of microbiology. To them a biologist is a bacteriologist.

So in pressing for more adequate preparation of students in biological science we need to make sure our administrators and other colleagues recognize what we mean by the broad term biology. If we refer to general biology we should be sure they know we mean animals and plants and that we are including the major principles that hold for both types of organisms, as well as many of the variations.

To return to pharmacognosy, as the area of professional instruction is developing today, I believe a fairly accurate concept of it to be an applied and advanced " general biology" - of natural drugs.

For drugs derived from multicellular plants and animals, the pharmacognosist is interested in their morphology - both gross and microscopic. He needs to know the taxonomic position and name of the plant or animal source. Cellular constituents are of prime interest, as is whatever may be known about the biosynthetic processes which lead to their formation. Therapeutic and pharmaceutic applications are of practical importance, as ofttimes are data on geographic distribution, culture, collection, commerce, and preservation. The pharmacognosist needs information on the control of parasites and of biological pests - plants, insects, rodents. From the province of microbiology he draws for knowledge of natural drugs of microbial origin and from immunology for information on serums and vaccines.

Scarcely a phase of general biology or a specialized subscience of both zoology and botany fails to contribute something to knowledge of natural drugs and their useful derivatives.

Which leads to a final point with respect to the matter of general biology as a prerequisite for pharmacognosy. From the point of view of a student in an undergraduate class in pharmacognosy, how much more meaningful would this general biology of natural drugs be if, in addition to general biology, one or two advanced courses in biology, organic chemistry, biochemistry and microbiology could precede the course in pharmacognosy!

To me it does not make sense to try to present in some detail organic products of biosynthesis when the student is just starting organic chemistry. Or to discuss extensively antibiotics, serums and vaccines when bacteriology is coming up next year. Yet in many of our colleges, perhaps in more than otherwise, pharmacognosy is taught before biochemistry, before bacteriology and before or at the same time as organic chemistry.

Pharmacognosy can logically be presented during the same year as biochemistry and bacteriology - the junior year. Assuming that the course in pharmacognosy is a two-semester one, that organic chemistry has been presented during the sophomore year (as it now is in a substantial majority of our colleges), that biochemistry is a first semester junior course and bacteriology a second semester junior one, the course in pharmacognosy can be pitched at a level which holds far greater interest for the student and permits treatment far in advance of that possible in a freshman or a sophomore course in pharmacognosy.

I recognize that for many years pharmacognosy has been considered by many pharmacy teachers to be a prerequisite or corequisite for the course in pharmaceutical preparations. There are advantages in having knowledge about Belladonna the drug when a student prepares Belladonna Tincture. But the information essential at this level can be put in a sentence or two. It is far more important to have the student well grounded in organic and biochemistry before Belladonna the drug is studied in detail.

Pharmacognosy is not the climax course in the biological sequence of the pharmacy curriculum - that position belongs to pharmacology. But modern pharmacognosy is not the rote memory type of course that characterized the curriculum of a generation or so ago. I believe that the subject matter of general biology as well as the general biological approach is essential as one of the prerequisites of pharmacognosy, but I also believe that we must increase especially the chemical prerequisites and insist upon biochemistry and bacteriology as corequisites in order to teach modern pharmacognosy at a level commensurate with its subject-matter.

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Bacteriology and Microbiology as a Prerequisite to Pharmacognosy

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The two terms Bacteriology and Microbiology are frequently used interchangeably, which is not necessarily correct. Bacteriology is a science restricted to the study of pathogenic and saprophytic monocellular microbes. Microbiology however covers a considerably wider area; besides the study of bacteria it includes Protoaoz, Yeasts, Molds, Viruses and Bacteriophage. Microbiology then covers the " Micro kingdom" in a less restrictive fashion and includes all light or electron-microscopically visible, biologically active agents.

I would like to suggest then the Pharmacognosist, Pharmacist and the Pharmacologist be interested and acquainted with general Microbiology rather than restricting himself to the field of Bacteriology. It is hoped that the following examples, which point out in condensed form the relationship between Microbiology and Pharmacognosy will justify the foregoing suggestion.

The most fundamental task in Microbiology is the isolation and identification of specific organisms, If we have a culture plate seeded with pathogenic Microbes and the plate becomes contaminated with various bacteria, yeast or molds and some inhibitory activity is observed, we must be able to isolate and identify the active componant in order to investigate its possible pharmaceutical valu

There are many molds of the Genera Penicillium which may contaminate bacterial cultures, but there is only one Penicillium notatum westling isolated by Fleming and identified by Thom which led to the discovery of penicillin.

There is another significant aspect to the observation and identification of microorganisms, namely in the manufacturing of biological products. You all know what it would mean to have a pyogenic micrococcus as a contaminant in adrenalin--or any other drug-containing ampoule ready for clinical use. A catastrophe for the patient, the physician and the pharmaceutical house would become inevitable. Such incidents occur, and I would like to give just one example which happened in the San Francisco Bay area. Five cases of a mysterious death were reported to the Health Authorities. The fatalities occurred a few days after the patients were given isotonic salt infusions. A few of the isotonic salt solution bottles from the same pharmaceutical house were made available for laboratory studies. Escherichia Coli organisms were obtained from the pint bottles in sufficient number to cause a fatal coli septicemia in a dog. Further investigations revealed inadequate bacteriological control on the part of the manufacturer.

The foregoing example demonstrates clearly that the awareness of the importance of fundamental microbiological knowledge in pharmaceutical manufacturing can never be overemphasized.

The study of the pathogenicity and chemical structure of microorganisms is also of fundamental importance in pharmacognostic research. I would like to illustrate this in a classical example. Active, pathogenic tubercle bacilli can be rendered apathogenic upon numerous passages in ox-bile media and subsequent cultivation on potato slants. This observation was made by the French investigators Calmette and Guerin at the Pasteur Institute in Paris, and led to the introduction of the first and only vaccine against tuberculosis. This so-called B. C. G. (Bacille Calmette Guerin) vaccine is relatively widely used in infant vaccination wherever medically indicated.

An example stressing the significance in studying the chemical structure of microorganisms which might result in the successful separation of harmful from beneficial components, is the one of tuberculin. Robert Koch's old tuberculin, consisting of inactive tubercle bacilli was used with questionable success for many years to determine the sensitivity of an individual to tuberculosis. Many falsely positive reactions occurred due to substances which had nothing to do with tuberculosis sensitivity. Today it is well known that an extract of Tubercle bacilli called P. P. D. (Purified Protein Derivative) represents a safe, dependable diagnostic reagent free of nonspecific reactions.

An example based on similar observations led to the successful separation of bacterial pyrogens from certain microorganisms. Nonspecific fever therapy was known and applied for many years in the treatment of asthma and other allergic disorders. It was also used in breaking the sulfonamide resistance which was thought to be a function of the host rather than the parasite. Those treatments, however, were highly dangerous since active infections with pyrogenic organisms had to be produced. Today we have pyrogens available as highly purified Polysaccharides obtained from Pseudomonas and Proteus organisms, which can be administered in a controlled fashion, thus eliminating undesirable side effects.

Microbial metabolism has become an eminent field not only in relation to the understanding of the nature of infectious diseases but also in relation to pharmacognostic research.

It was Edward Buchner who observed in 1896 that the presence of a yeast is not necessary to obtain fermentation of sugar. He demonstrated that a yeast culture can be filtered through the now famous Buchner filter, and although a cell-free filtrate was obtained, it would still ferment sugar.

Metabolic products of the yeasts which are known as hydrolytic enzymes were responsible for the fermentation. Subsequent studies have resulted in the extraction of numerous enzymes from culture filtrates of various microorganisms. Most of them are utilized extensively by the Food and Beverage industries; some are used, however, as important tools in medicine. For example, Hyaluronidase, a hydrolytic enzyme, can be obtained as a metabolic product of certain Streptococcus strains. It has frequently been referred to as an invasive enzyme because of its ability to break down the "tissue cement" or chemically hyaluronic acid, hence it promotes the diffusion of the organisms into the tissue. Hyaluronidase is now used extensively to promote the diffusion

of injectable fluids, thus a blood titre of a given drug can be obtained almost as fast by giving it intramuscularly as when given intravenously. And, as you know, certain drugs just cannot be given intravenously, and yet a rapidly obtained blood titre is highly desirable. Streptokinase, also a metabolic product of certain Streptococci is now in general use for the dissolution of blood clots. The scientist who works on those types of problems, trying to obtain therapeutic agents of microbial origin should also be acquainted with the immunological aspects of the products. The two biologicals Hyaluronidase and Streptokinase just taken as typical examples, are proteins by nature, and although used in minimal quantities they stimulate the production of specific antibodies. This, of course means that their value upon prolonged usage diminishes due to antibody formation.

The blessings of the introduction of antibiotics into the therapeutic repertoire of the physician are well understood. Penicillin, Streptomycin, Terramycin, etc., are all metabolic products of microorganisms. They are at the present time still manufactured by means of microbiological procedures, with the exception of Chloramphenicol which is now synthesized. There are hundreds of antibiotic substances obtainable from various microorganisms but only a few of them are ultimately suitable as therapeutic agents. The effectiveness, low toxicity and availability in great quantities are just the more important factors which will determine the value of an antibiotic substance. The more we know about microbial metabolic processes the better is our chance to exploit the "micro-kingdom" for the benefit of mankind. Although we are fortunate enough to have these powerful drugs at our disposition, we still need more. A frightening increase of antibiotic resistant disease producing agents has been reported. We must realize that a given microorganism might not only become resistant to the drug, but may utilize the antibiotic as a growth factor. This very fact should be enough to convince us of the need for more antibiotic substances.

Rickettsia and viruses have so far not been utilized in obtaining therapeutic agents. This is probably due in part to the lack of detailed knowledge of the metabolic activity of these agents. But on the other hand they are basically entirely different from other microorganisms. They are not only considerably smaller in size, which as such makes viral and rickettsial research difficult, they are also obligate parasitic, which means they cannot be grown in any artificial media without the presence of a living cell. Viruses and rickettsia parasitize intracellularly, and since they are chemically almost identical it is difficult to determine where the parasite ends and the host begins. This very situation makes us aware of the fact that we do not only need an entirely different approach in obtaining therapeutics from viruses and rickettsia, but also in obtaining therapeutically active agents against these types of parasites. Again I would like to emphasize the close relationship in the chemical structure between parasite and host cell. It might be relatively simple to get a drug which is highly active against bacterial agents without being recognizably toxic to the host, but when we have a parasite consisting mainly of nucleoprotein and a host cell which is mainly nucleoprotein, the situation becomes considerably more complex.

At this point I would like to offer a suggestion. A phenomenon of interference between antigenically different types of a given virus or rickettsia can

frequently be observed. For instance, influenza virus occurs in three antigenically different types, namely A, B and C. An excess amount of either type will suppress the others, which means an excess amount of Type A virus together with B and C type will suppress the latter ones. If we could isolate the component which is responsible for this interference phenomenon we could use it therapeutically in a given epidemic area, since the results of numerous epidemiological studies indicate the presence of only one virus type in a given area.

There is still another group of agents, biological in origin although nonpathogenic to man and animal, namely bacteriophages. These agents are actually bacterial viruses and would as such be obviously useful as therapeutic agents. An amazing specificity exists in the action of a bacteriophage upon a given microorganism. Most of the phages attack certain enteric bacteria, and yet their therapeutic value has not been established. This very situation must make us realize the difference between in vitro and in vivo reactions. I feel that it is of enormous importance in the evaluation of a therapeutic agent to realize this difference. Unless we are able to provide a similar environment in vitro as we have in vivo we must realize the shortcomings in our in vitro laboratory experiments. To emphasize this point I would like to mention that we can cure poliomyelitis in the test tube, but at the present time not in vivo.

We have so far briefly discussed some of the ties between Pharmacognosy and basic microbiological observations. It is quite evident, however, that the study of possible therapeutic agents other than the ones obtained from microorganisms directly but used in the treatment of infectious diseases requires also a certain knowledge in microbiology, particularly in relation to the host-parasite relationship. If we take, for example, ACTH or Cortisone as therapeutic agents against chronic infections we must consider the physiological action of the drug which happens to be suppressing upon inflammatory processes. Such an observation is, of course, very significant and opens tremendous possibilities for the use of the drugs. We must however understand that the suppression of inflammatory processes means a suppression of an important phase of the natural body resistance against infectious disease producing agents. Hence a sufficient understanding of defense and immune reactions is mandatory for the investigating scientist.

I would like to summarize my brief presentation by emphasizing a few points:

1. A sufficient background in Microbiology is truly one of the basic prerequisites for achieving the objectives in Pharmacognosy.

2. Microorganisms and their products offer an excellent source in the search for potential therapeutic agents.

3. The student in Pharmacognosy should not be overwhelmed with detailed theoretical and technical concepts of Microbiology, but he should be taught the basic understanding of microbial processes.

Human Physiology and/or Anatomy as a Prerequisite to Pharmacognosy

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The courses required in pharmacy, in common with those required in other professions, may be divided into three groups which I should like to call pre-prefessional courses, transitional courses, and professional courses. In the biological science sequence, general biology, botany, and anatomy represent the pre-professional courses, whereas physiology and pharmacognosy may be considered transitional courses leading to pharmacology, the professional course in this area. When placed in this position, pharmacognosy occupies a unique and important position in the pharmacy curriculum. Indeed, it contributes heavily not only to pharmacology but also to dispensing pharmacy and to pharmaceutical chemistry. In view of the extensive contributions of pharmacognosy to these capstone courses, it is important that the pharmacy student be required to take such pre-professional courses as will enable him to receive maximum benefit from his work in pharmacognosy. It is the purpose of this paper to consider how two such courses, anatomy and physiology, can serve as useful prerequisites to pharmacognosy. It is written under the assumption, however, that pharmacognosy has been organized to serve as a fundamental transitional course in the biological area in keeping with current trends in pharmaceutical education.

Attention should be directed to the fact that the American Council on Education, through the Pharmaceutical Survey, has recommended that vertebrate anatomy and histology, and physiology be included in the biological science sequence. This recommendation needs no justification since both of these courses contribute to the basic knowledge necessary for understanding the mechanism of drug action. Inasmuch as these courses are not included in the program of all schools of pharmacy, it seems logical to review briefly their content and relative position in the curriculum.

The course combining anatomy and histology, consisting of 32 hours of didactic instruction and 96 hours of laboratory work, should follow that in general biology. Gross anatomy should be considered in the initial one-third of the course, covering the bones of the skeleton rather briefly, then proceeding to regional anatomy, to the individual organs and structures within the body cavities, and finally, to the groups of organs which form the various systems. Only the general aspects of anatomy should be considered; a detailed study of muscles, nerves, and small blood vessels would waste valuable time and not contribute materially to subsequent courses. The remaining time should be devoted to the portion of the course dealing with histology. In general, here should be reviewed briefly the cell theory and mitosis, followed by a study of the elementary tissues, such as epithelial, connective, and supportive; consideration should then be given to muscles, nervous tissue, blood, lymph, and finally a study should be made of the tissues present in each organ. The material on anatomy in such a course would familiarize the student with the general location of the various bones, organs, and systems of the body, whereas the instruction in histology would provide the more detailed information necessary

for an understanding of physiology and other biological sciences.

The physiology unit, as recommended by the pharmaceutical survey, should consist of 64 hours of didactic instruction and 96 hours of laboratory work. This course should be taken after anatomy and before entering pharmacognosy. A physiology course which is intended to prepare the student for subsequent courses in pharmacognosy and pharmacology is very different from the physiology usually taught in the Arts and Sciences schools. This course should deal essentially with human physiology and should be concerned primarily with the functions of cells, tissues, organs, and systems. In addition, it should consider in some detail various aspects of pathological physiology. The fact that drugs, in the majority of instances, bring about their salutary effects by amending an abnormal physiological function justifies the placement of emphasis on this portion of the course. Such emphasis will set the stage for a rational approach to the drug therapy of congestive heart failure, cardiac arrhythmias, hypertension, and the many other conditions which indicate abnormal physiological functions.

It is obvious that this type of physiology course will support most firmly the subsequent teaching of pharmacology. Nevertheless, both of the courses previously described serve pharmacognosy by providing basic information which is of definite value to this transitional course. The attention of the pharmacognosist has been directed repeatedly to the fact that "too little attention has been given in pharmacognosy to animal products, to relationships between plant and animal constituents, to the physiological importance of drug constituents, and to the correlation of these aspects with organic synthesis." (1) It is along these lines that anatomy, histology, and physiology make their most significant contributions.

The course in anatomy and histology provides the student with a great deal of information which is of value in pharmacognosy. For example, the student may read in his pharmacognosy text that "the parathyroids are small, rounded endocrine glands, four in number, located in the tissue of the dorsal surface of the thyroid lobes" (2) or the medullary portion of the adrenal gland is described as consisting of "numerous polygonal to somewhat lobed and stellate, chromophil or chromoffin cells arranged in irregular groups and anastomosing cords that are surrounded by connective tissue containing blood vessels, blood sinuses, capillaries, nerve fibers, and ganglion cells." (3) How can we expect a student to read and comprehend such material without having previously acquired some understanding of anatomy and histology. Numerous examples could be given testifying to the prerequisite value of anatomy and histology to other facets of pharmacognosy, but only two will be cited. Some familiarity with the various routes by which drugs are given is necessary for interpreting basic posology. Inasmuch as drug doses are given consideration in pharmacognosy, an anatomical knowledge of the sites and locations involved in the administration of drugs, such as the gluteal and deltoid muscles, intrascapular region and buccal cavity, would enable the student to understand such terms as intramuscular injection, intrascapular transplant and buccal administration. The fact that pharmacognosy is concerned with the source of all therapeutically active constituents of animal origin is further evidence as to why

fundamental training in macro- and micro- anatomy is prerequisite to a study of this subject. For example, it would be impossible to separate the pituitary gland into its component parts without such knowledge. Furthermore, a familiarity with the histology of the gland is essential to an understanding of current theories regarding the formation of its hormones.

The value of physiology as a prerequisite to pharmacognosy is somewhat easier to visualize, especially if the teacher in pharmacognosy employs a physiological classification for presenting the material. However, irrespective of the system of classification employed, a comprehension of physiology will contribute greatly to the student's ability to understand the details presented in the subject. Much of the material presented in pharmacognosy textbooks deals with the physiological aspects of the drug. One or two examples taken from well-known textbooks on pharmacognosy will suffice to illustrate this point. " Physostigmine affects the activity of the autonomic nervous system largely through its ability to inhibit the action of the enzyme, cholinesterase, in the effector cells and the body fluids. By restraining this enzyme, which normally functions to destroy acetylcholine, physostigmine enables acetylcholine to exert prolonged stimulating effects on the autonomic system and elsewhere in the body. The uses of Belladonna and its preparations are numerous. Of course these are based on the nerve-depressant activities of the alkaloids which, by blocking normal responses of smooth muscles and secretory glands to cholinergic stimulation, permit normal adrenergic stimuli to act unrestricted. " (3) It should be obvious that the understanding of such material presupposes that the student is familiar with the chemical theory of nerve transmission and the physiological function of the autonomic nervous system. Physiology serves to make the therapeutic uses assigned to the drugs mean something to the student. Thus, if the student has a thorough understanding of the normal function of the respiratory, circulatory, hemopietic, and urinary systems, as well as conditions which result from their abnormal function, such terms as respiratory stimulant, cardiac stimulant, hematinic, and diuretic will take on a more significant meaning. Familiarity with the symptoms which occur in the human body as a result of a hypo- or hyper- function of the various glands contributes to the understanding of the therapeutic uses assigned to the products of glandular origin. Likewise, the role of vitamins in the human body can be appreciated only if the student has a knowledge of the physiological role of these substances. In a similar manner, it would be difficult for the teacher in pharmacognosy to present the subject of allergens to a group of students entirely unfamiliar with histamine and the histamine theory of allergic manifestation.

Finally, it should be remembered that pharmaceutical education prepares the student for highly specialized services which can be rendered only by those who have had an extended period of training at a high intellectual level. As the profession of pharmacy is now practiced, there is scarcely an aspect of the biological sequence which is not of value to the training of the pharmacist. Because pre-professional courses, such as general biology and physiology and anatomy are fundamental to this area of instruction, it behooves the teacher of pharmacognosy to organize his course in such a way that it will serve as a valuable transition from these courses to pharmacology. The prerequisite value of anatomy and physiology to pharmacognosy is conditional

upon this organization. Indeed, the ultimate value of pharmacognosy itself to the overall training of the pharmacist depends upon how well this is accomplished.

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The Application of Organic Chemistry in Pharmacognosy

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Attempting to explain the application of organic chemistry in pharmacognosy is much akin to discussing the application of arithmetic in accounting, or English grammar in a course in writing. The problem of the speaker is thus compounded since he may be tempted to brush aside important considerations on the grounds that they are ridiculously obvious, or at the other extreme he risks boring his listeners with a recitation of facts already known. I feel particularly humble as an avowed pharmaceutical chemist appearing before a group of experienced teachers of pharmacognosy to discuss a topic which they doubtless know more about than I. However, proceeding on the assumption that the recounting of one's blessings is good for the soul, I shall attempt to remind you of the ways in which organic chemistry applies to pharmacognosy and perhaps in the process suggest an item or two which might be new to some.

The close relationship between the two subjects is dramatically illustrated by their respective definitions. Allow me to quote from my old undergraduate organic textbook: "An organic substance, as the term was originally applied, meant a chemical substance present in and obtainable from plant and animal organisms but not obtainable from mineral or other inanimate sources." (1) Of course this old definition is too narrowly restrictive according to modern knowledge, but the relationship of organic chemistry to plant and animal products is still valid. Compare this definition with the following statement from a modern textbook in the field of pharmacognosy: "Pharmacognosy deals largely with the examination and the evaluation of active principles which plants and animals synthesize." (2) The similarity is obvious.

In their monograph THE PHARMACEUTICAL CURRICULUM, Blauch and Webster in speaking of the definition and scope of pharmacognosy say, "It may include reference to those synthetic substances that are related chemically or physiologically to products of biological origin." (3) Thus, since pharmacognosy does not shun entirely those substances of synthetic origin, even our most modern, all-inclusive definitions of organic chemistry are intimately associated with those of pharmacognosy.

It seems only natural, in view of the overlapping between the two fields, that organic chemistry should serve as a prerequisite for pharmacognosy. Certainly no one of you will doubt the desirability of such an arrangement if the best job of teaching is to be done. However, prerequisites are like the eternal female in that they do not relish being taken for granted, so a few minutes spent in reciting how and why we appreciate them should be worthwhile.

With the emphasis shifting from strictly taxonomic and morphological classifications of natural drugs to physiological, therapeutic, and particularly biochemical classifications, the need for a sound organic chemistry background becomes more acute. In fact, I personally feel that such a background is equally necessary regardless of the approach used by the instructor in his teaching.

From the standpoint of pharmacy and medicine, the most important thing about a natural drug is its active constituents; therefore, they certainly should be discussed under any system of classfication.

The situation is much like that which exists in connection with the course in Organic Medicinal Products, i.e. shall we use the chemical or the pharmacological system of classification. Actually it is a matter of personal preference and makes little difference since we end up teaching essentially the same information anyway. It is inconceivable to me how the instructor of pharmacognosy can provide a well-rounded picture of a natural drug without some discussion of the chemical nature of its active ingredients. This certainly is not a new idea as revealed by the following quotation from the 1920 edition of Kraemer: "The ultimate aim of the science of pharmacognosy is to obtain a knowledge of the chemical nature and properties of all commercial products, from their origin in nature to the final changes in their manufacture. To attain this object requires that the student in pharmacognosy should be well trained in chemistry." (4)

If the class has not had organic chemistry previously, such discussion is largely wasted since chemical formulas, particularly of aromatic and heterocyclic compounds, are just so many hieroglyphics to the neophyte. Thus if the instructor sincerely desires to round out his presentation and make sure it is understood, he must take valuable time to indoctrinate his students into some of the mysteries of organic chemistry. As you are all aware, this time just isn't generally available in the overcrowded four-year curriculum. It's not difficult to see how much more a discussion of glycoside-containing plants would mean to the student who knows what a sugar is chemically and how it may be combined with an aglycon. Also think how much easier it is for the teacher to discuss the occurrence, isolation, and purification of alkaloids to a group of students who know what a nitrogen base is. Similar references may be made to each class of plant constituents and animal products.

In a number of schools of pharmacy, pharmacognosy and organic chemistry are taken concurrently. Such an arrangement, however, does not solve the problem since aromatic and heterocyclic compounds are not covered in the courses in organic chemistry until the second quarter or semester. I seriously doubt whether even the most ingenious of pharmacognosy teachers could logically arrange a course wherein all those drugs containing such compounds are discussed near the end. A semi-concurrent arrangement whereby pharmacognosy was begun one quarter or semester following the beginning of organic chemistry would be an improvement, but still no substitute for requiring the completion of organic before pharmacognosy is taken. When the latter is done, the teacher's task is made easier because he may concentrate on presenting his subject matter at a higher level which is more valuable and meaningful to the student.

The discussion thus far has consisted largely of generalizations about the desirability of the organic chemistry prerequisite. It is perhaps time now to get down to facts and see what specific applications of organic chemistry can be made in pharmacognosy. There are many, of course, but let a few suffice to serve as examples.

Starting at the beginning, let us consider biosynthesis for a moment. It would seem to me that this is one of the important considerations of pharmacognosy, but the discussion of biosynthesis would be lost completely on the student without training in organic chemistry. What is an amino acid, a hexose, a polysaccharide, a glycoside, a fixed oil, a terpene, an alkaloid, etc.? All these terms must be used continually. Are they just words to be empirically bounced off the eardrums of the unsuspecting student, or will they convey a meaningful impression to be integrated with other information? Pharmaceutical education is emerging, albeit slowly and even reluctantly in spots, from the age of empiricism. We may no longer make statements without explaining "why". We cannot just say that such and such a compound is soluble in water and not in organic solvents. A rational explanation is expected and deserved by the student. The increasing emphasis on a stronger background in the basic sciences such as physical chemistry and physical pharmacy indicates the trend in all of the pharmaceutical disciplines. Understanding without foundational knowledge is impossible.

Application of organic chemistry to pharmacognosy may also be found in the study of the preservation and protection of crude drugs. Why, for example, must adrenal glands be dried and powdered in vacuo and at low temperatures? Recognition of epinephrine as a phenolic compound and the ease with which phenols are oxidized provides the answer. Without this information the importance of such safeguards is lost.

Methods of extraction of active ingredients may also be explained on the basis of the chemical constitution and physical properties of the compounds in question. The student may memorize the fact that alkaloids are obtained from plants by treating the ground drug with aqueous base and then extracting with an organic solvent such as chloroform, shaking that out with aqueous acid solution, adding base and re-extracting with chloroform, etc., but he does not understand why this is done unless he knows something of the chemistry of nitrogen bases.

Numerous microchemical and macrochemical tests are used in determining the identity, purity, and quality of crude drugs and their products. The association of this phase of pharmacognosy with organic chemistry is obvious and needs no further classification.

Similarly, the students' background of knowledge in organic chemistry can be utilized by the instructor in presenting the pharmaceutical uses of natural products and in explaining why a particular type of formulation should be used with this and that drug, etc. You who are actually doing the teaching of pharmacognosy can, of course, supply many more examples of specific application.

At one time pharmacognosy was rather narrowly defined. In many schools of pharmacy it was offered merely as a branch of the old materia medica. Today the area or discipline of pharmacognosy in our pharmaceutical curricula embraces much more than the rather restricted "study of medicinal plants and their crude products ...." (5) A glance at the program of this Seminar will reveal the

variety of subjects directly related to it. For example, antibiotics, immunizing biological products, allergy and allergens, and pesticides are logically discussed under the heading of pharmacognosy.

In the past few years man has begun to wage war on plant and animal pests in ever-increasing intensity. Research in the field of pesticides has produced hundreds of new compounds for the control of insects, fungi, rodents, weeds, etc. Such products are logical drug store merchandise and the pharmacist, by virtue of his training and experience, should be the person to whom users of these preparations can turn for advice. However, the business in insecticides, weedicides, rodenticides, and fungicides has in many cases by-passed the drug store for the feed store, hardware store, supermarket, florist, and others. Pharmaceutical educators are now beginning to realize the service which the pharmacist can render in this field and so we find specialized training in pesticides appearing in our curricula either as part of existing courses or as new and separate courses in the area of pharmacognosy or elsewhere.

A majority of these pesticidal compounds are organic in nature. Therefore, here again previous training in organic chemistry is absolutely necessary. In fact, since the senior year is the logical time for such a course, pesticides can follow organic medicinal products as it does in the speaker's own institution. I shall elaborate more on the correlation between these latter two courses in my second paper later in the week.

The chemistry of the antibiotics has been pretty well worked out, at least for the more important ones, and so here again we find an opportunity for application of organic chemistry in pharmacognosy.

In summary, it has been pointed out that organic chemistry and pharmacognosy are closely related by definition, that good chemistry training has been considered a necessary prerequisite for many years, and that the job of the pharmacognosy instructor is much easier in that a higher level of instruction is possible. Also, a few specific examples of the application which organic chemistry finds in pharmacognosy have been presented by way of illustration.

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Section D - TEACHING METHODS

The Philosophy of Teaching

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The inclusion of the topic " The Philosophy of Teaching" in your Seminar is but another evidence of the great concern for teaching to which your many-sided and exciting program gives abundant witness. And your invitation to a Director of General Education to speak to this topic indicates the breadth of your interest and the close and fruitful cooperation which has existed in the University of Utah between the College of Pharmacy and the General Education Office of the University College. I am sure that you will pardon the personal reference when I tell you how grateful I have been to Dean Hiner and to the two General Education Counselors whom we have had from the College of Pharmacy since the inception of our program, Dr. Orr, now Dean at Montana, and Dr. Osborne. Their constant support and significant contributions have made possible the complementary relationships between general and professional education envisioned in our university programs today but all too seldom attained.

I.

In The Mind in the Making, published just after World War I and now an American classic, James Harvey Robinson wrote: " We do not think enough about thinking, and much of our confusion is the result of current illusions in regard to it." I believe this statement to be also true of that special manifestation of thought which we call teaching and its concomitant, learning. And I say this with all due recognition of the enormous activity about teaching going on at this moment in hundreds of Summer sessions all over the country. I do not mean to deprecate this activity nor to depreciate all that we learn from it but only to point out that I believe most of it to be focused on the mechanics and methods rather than the philosophy of teaching. By the philosophy of teaching I mean the study of the principles and values of the science and the art of teaching. For teaching is both art and science, and unlike heroes (however else they may resemble them), good teachers are both born and made.

What, then, are these principles and values? It will not be surprising if they turn out to be quite obvious and if the statements of them sound like clichés.

II.

Some years ago a friend of mine, a professor of electrical engineering, was faced with one of those questionnaires which have become the bane of academic life. " What do you do in Electrical Engineering 80?" asked this sprightly document. Keeping a firm grip on himself, my friend wrote, " I teach electrical engineering." " What is your purpose in this course?" continued the remorseless investigation. At this my friend exploded, complete with exclamation points, " I aim to produce the best damned electrical engineers I can out of the material I get!" Any teacher in a professional field will readily understand his exasperation, nor will those in the liberal arts fail to sympathize. We all remember such questions as " What are your norms for the appreciation

of Shakespeare?"

In his annoyed outburst, my friend gave colorful expression to the first great principle of teaching, mastery of and devotion to the subject taught on the part of the teacher, leading to a rigorous concern for a like mastery and devotion on the part of the student. In recent years this principle has come under considerable attack as a result of the failure of many specialists to be concerned with the student as well as the subject, and we have all been subjected ad nauseam to the parroting of "I teach students not subject matter," by those who are misled by the grammatical play of direct and indirect objects involved in that statement, which made it a good educational wisecrack and half-truth for the doomed innocent who first used it. Whatever the damage done in general education, in the liberal arts and sciences, and therefore in preprofessional training - and the damage has been considerable - there has been no real danger to the observance of the principle in professional fields like your own. The demands of the profession have made observance axiomatic and the principle itself has been clearly understood not only on the part of the teacher in the profession, but also, and of more importance, on the part of the professional student. Yet it is so clearly basic in all fields of teaching that I am sure we would all agree with the college president whom I heard declare recently, "I would never appoint anyone to my faculty, if I could help it, who did not believe his subject to be the most important in the curriculum."

I take it that it must also follow that mastery of and devotion to one's subject involves the obligation to keep up with new knowledge in the field and wherever possible to contribute through research and publication. However, though ideally research and teaching should complement and enrich each other, I do not believe that we can hold uniformly to this position in all fields, or on all levels, or with all teachers and researchers. In actuality, there are elements in these activities which can be antipathetic and even antagonistic, and we all know many striking examples of men with such strong inclinations toward teaching or toward research that to insist on a major effort in the other would be psychologically unsound and even result in a loss in overall contribution.

III.

Important as our first principle is, it must never blind the teacher, as it so often does, to the relationships of his field to the larger areas of knowledge and finally to life itself. And so our second principle is a recognition of the subordinate place of the subject in the total scheme of things. It was here that in his understandable irritation my electrical engineering friend missed the significance of the questions put to him, though, true scientist and very able teacher that he is, he is quite aware of this second principle and would be among the first to insist upon it.

Though neglect of the larger relationships of their subjects or refusal to recognize them is a common failing of teachers in all fields, I believe it is a special danger in professional education and for the very reason that the first principle is so clear, the demands of the profession and loyalty to it. From a failure to observe this second principle comes, I am sure, more than any

other source, the failure of professional education and the liberal arts and sciences to form an effective common front for an adequate general education. But what is perhaps of still greater importance it often blinds the professional educator to the general education implications of his own subject. If I can judge from the constant emphasis in your program on the relationships of your subject to other subject in the pharmacy curriculum, to the other medical sciences, and to biological science in general, this is no problem to the teachers of pharmacognosy here assembled. But how often do we see both teachers and students in the sciences thoroughly conversant with the detailed knowledge of their fields but utterly ignorant of what science is, of its role in our culture, of its philosophical implications; exacting and objective in their laboratories, but really so little aware and respectful of science's methods of seeking the truth that they are scornful and impatient of the equally rigorous but different methods employed, let us say, in the humanities. One of the finest and most imaginative scientists I know is fond of telling me with delight, "I don't know a thing about art, but this is the truth about it." Regardless of what we once believed, the larger implications will not come of themselves, unsought, and if we wish transfer of training we must teach for it. For instance, freshman chemistry will not help to arm the student for the ancient battle against prejudice and authoritarianism unless the teacher is constantly aiding the student to realize that objective observation and verifiable experimentation are dependable weapons when the issue is joined on other days on other fields. Our greatest teachers have always sought these larger implications, for they have realized, consciously or unconsciously, that education is, as I heard President Chalmers of Kenyon College say recently, the discovery of what the important questions are.

IV.

The third principle I would call a concern for method. Neither as artist nor as scientist can the teacher afford to neglect the techniques of his trade; the best teachers have always exhibited a lively concern for them. It is encouraging to note everywhere in the colleges and universities today, as in your seminar here, a growing awareness of the importance of how we teach and the recognition, though often grudging, that this is a legitimate and highly significant area of investigation for the so-called subject matter areas as well as for education per se. And we must pardon our friends and colleagues in the Colleges of Education if they smile indulgently at our naïveté and our slowness of realization, for they have been telling us this for years and we have obstinately refused to listen.

A concern for method implies an objective analysis of the results of what we actually do in the classroom as well as a deliberate planning of what we intend to do, a willingness to entertain and to try out new ideas and methods, and an active desire to share our experiences with others. We all know the teacher - often a very good one - who, like the recipe-cherishing housewife, is afraid to exchange formulas, either for fear that someone else will do as well as he or that his own methods will prove inferior.

What I have been saying indicates that I firmly believe in a well-planned and supervised training period for teachers in higher education. Ours is

perhaps the only major profession that does not have such a mandatory internship as part of its program of preparation. Most of us were trained as scholars without a word about the teaching process. When we faced our first classes, we imitated the teacher we liked most until we could stand on our own feet. Fortunate were our students if our choice was a good one and the style of the master was not too unsuited to the apprentice.

Concern for method and belief that college teachers can be trained does not mean, however, that there is a method that all can and should learn. Far from it! We must remember again that teaching is an art as well as a science and that some methods will suit one person and not another, just as some methods will be appropriate for one subject and not another or for one group of students and not another. In late years, for example, there has been a violent attack upon the lecture system, much of it justified. Yet all of us can remember great teachers who were superb lecturers from whom we learned much and in whose classes substitution of the discussion method would have meant a grievous loss to the students. If there is any one maxim that all teachers should learn it is probably: Be yourself.

V.

The fourth principle, a concern for students, is so closely tied to a concern for method that one immediately implies the other. Teaching simply means helping some particular student to learn something, and all our concern with method is designed to make the learning process more effective. Both principles, therefore, involve more and more attention to how and why students learn. My psychologist friends tell me that we know all too little in the field of learning theory but that much interesting and significant work is being done. All seem to agree, however, that students learn by doing, though by doing they do not mean, necessarily, overt activity. For example, students learn to write English by writing English. This principle seems simple and obvious enough, yet we often forget it in practice. No football coach, however, would make such a mistake.

Concern for our students means so far as possible learning who they are, where they come from, why they are here, what they look like in terms of the many excellent diagnostic devices used in most of our institutions but all too seldom put to use. Here the individual teacher and the professional counselor work hand in hand. Far from lessening the significance of the teacher as counselor the institution of student personnel services has increased his importance and his capacity. Every well-trained counselor knows that any teacher, even that little quiet fellow over there, whom you have always thought dull and pedestrian, may be the one who for a particular student will " open the oyster of the world. "

Finally, a concern for students means a respect for students, for the unique personality of each. It means that we will create a positive and democratic rather than a negative, authoritarian attitude in our classes, that each student will be encouraged to feel that he has a contribution to make

which his instructor and his fellows will take seriously. This does not mean for a moment that we abandon standards, that we tolerate slovenly, careless, irresponsible work. The experience of rigorous and precise thinking, the pride of competent work produced by long and patient preparation, the thrill of sound intellectual achievement are the birthright of every serious student; we cannot be said to have a concern for students if we do not see that they get their birthright. The point is that we can help them get it much more effectively and completely by positive criticism and encouragement than by negative criticism and arbitrary prescription, our goal being the fullest possible development of the capacities of each of our students.

The last principle is a sense of dedication to something beyond ourselves and our immediate tasks. It is very difficult to express, but the great teachers have all known it and have described it in various ways. It seems to many of us particularly difficult and even dangerous to discuss this attitude today. There is the very real danger of being misunderstood, of being regarded as one of those who desire to further a particular orthodoxy, who wish to break down the separation of church and state in the schools, who join in the hue and cry against secular philosophy and scientific humanism, good words standing for good things, which our enemies of freedom of thought, as Mr. Elmer Davis has recently been emphasizing, are doing their best to make smear words and evil names. And there is the equal danger of giving aid and comfort to those who, sentimentalizing this sense of dedication, would use it as a club of duty, as a specious reward, to justify low salaries for teachers, overloaded schedules, poor working conditions and facilities, and all manner of restrictions.

Yet the dedication is there in all real teaching, at once substantial and ideal. At the recent conference called by the Fund for the Advancement of Education I was much struck by the statements of various educational leaders that all over the country both teachers and students are losing their self-consciousness about the element of idealism in education and, despite the dangers I have mentioned, are once again willing to acknowledge it. As I have said, it will take various forms, this spirit of dedication; it will be different for you and for me; but it is at the core of our profession. It does not parade in the open with precept and proof; it works subtly by contagion; but it is the greatest gift the teacher has to give.

Here, then, are five basic principles of teaching: mastery of and devotion to the subject taught; recognition of the subordinate place of the subject in the total scheme of things; concern for method; concern for students; and a sense of dedication. I am sure that the list is not complete, that you will wish to add others and to rephrase the five I have given. As I look at them myself, I notice that I have phrased them rather as attributes of the teacher than as philosophical principles. I am sure that my colleagues in philosophy would scarcely recognize them as such. But perhaps it is better that way. You must all have noticed as have I that discussions of new educational schemes and curricula and reorganizations always come down at last to the teacher as the key to success. "Show me an institution with the right teachers," said an educational critic years ago, "and I will show you the right school!"

Thank you for inviting me to your Seminar. It was a great privilege to talk with you about the abiding questions of our common profession, which each day present the keenest of challenges and the highest of rewards to the eager and inquiring mind.

The Learning Process in Science

Lloyd E. Blauch
U. S. Department of Health, Education, and Welfare

Dr. Daniels, Members of the Seminar:

I have been asked to address you on "The Learning Process in Science." To deal adequately with this subject in all its important aspects would require considerably more than the thirty minutes allotted to me on this program. It has seemed advisable, therefore, to limit the address to several features of the subject that may have special relevance to your work.

Meaning of "Science"

Let me begin by asking what we mean by "science." Several dictionary definitions may be helpful. One says that it is "a branch of study which is concerned with observation and classification of facts, especially with the establishment (and, strictly, the quantitative formulation) of verifiable general laws, chiefly by induction and hypotheses," and specifically as "accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws." (Webster's New International Dictionary, Second Edition, G. and C. Merriam, Company, Springfield, Mass., 1941.)

A second dictionary defines science as "a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws" and more briefly as "systematic knowledge of the physical or material world." (The American College Dictionary, Random House, New York, 1951.)

A third dictionary defines science as "systematized knowledge derived from observation, study, and experimentation carried on in order to determine the nature or principles of what is being studied," as "a branch of knowledge or study, especially one concerned with establishing and systematizing facts, principles, and methods, as by experiments and hypotheses," and as "the systematized knowledge of nature and the physical world." (Webster's New World Dictionary of the American Language, College Edition. World Publishing Co., Cleveland, Ohio, 1953.)

I believe we have gone far enough with the definitions to note the main characteristics of science. First, science deals with the world of nature, although it is often defined so broadly as to include such studies as history and the study of social relationships, but when we use the word "science" without an adjective we usually mean the natural sciences. It is used in that sense in this paper. Second, it employs observation as a basic procedure. Third, in a science, facts are classified and systematically arranged. And fourth, science is concerned with the establishment of general principles and laws. These characteristics of science suggest several aspects of learning I want to discuss with you.

Direct Contact with Objects in Learning Science

In science we are concerned with learning about material or physical objects and their characteristics. Our knowledge about these things is acquired: (1) through direct experience with objects and situations, (2) through representations, such as pictures and models of objects and phenomena, and (3) through communication by means of symbols such as printed and spoken words. All of these ways of acquiring knowledge are basic in learning science Let us look at each of them.

A great deal of our knowledge of science is derived from firsthand experience with the material world through the various special senses of touch, smell, taste hearing, and sight. We have here what psychologists often call perceptual or observational learning. Other forms of learning are memorizing, problem solving, and motor learning. Perceptual learning is basic to all of these forms and is usually related to them. Rarely does it go on independently of other learning. It is of special significance in the study of science.

The term perception is used technically in psychology to mean the direct apprehension or recognition of objects (including their qualities and relationships) and situations that are present to the senses. 1/ Perceptual learning consists of those mental activities by which we learn to apprehend or recognize the large number of objects and situations in our world.

1/ Perception is contrasted with ideation (a term not often used), a form of mental activity in which the object or situation is thought of or imagined but is not present.

To illustrate, I see a man and at once I recognize him as John Jones. Behind this recognition is a body of experience I have previously had which enables me to link that particular name with the man I now see. The learning by means of which I came to do that was perceptual learning.

In perceptual learning there is extensive use of observation. As the psychologist uses this term it means to note carefully something that is presented to the senses, to scrutinize it, to examine it carefully.

When observation is carried on with great care for purposes of comparison, measurement, calculation, and verification, it may appropriately be called "scientific observation." Scientific observation is used in two different types of situations: (1) when the circumstances or conditions may be produced artificially and controlled, as in the study of chemical reactions; (2) when the circumstances or conditions may be selected but cannot be produced at will or controlled, as in the study of astronomy or anatomy.

Sensory Phase of Perceptual Learning

There are two phases in perceptual learning: the sensory and the interpretive. First, there is sensory experience; through the senses the individual becomes aware of an object or a situation, usually as a whole. The object or situation may not be clear; indeed it may be greatly confused to him. At once, however, he begins to supplement the sensory experience with his background of knowledge and feelings and to interpret the sensations he receives.

The learning about objects and situations through direct contact with them then depends first upon the experience the learner has through his senses. Limitations of the senses, such as the lack of development of a sense organ, or the deterioration or destruction of a sense organ, obviously limit the sensory experience one may have. It should also be noted that through the use of such instruments as the telescope, the microscope, the micrometer, the electrocardiograph, and a thousand others, sensory experience is greatly augmented.

Interpretative Phase of Perceptual Learning

The interpretative phase of perceptual learning may be thought of as taking place in two interrelated ways: differentiation and reorganization. In differentiation the details or specific features of the object or situation are analyzed and noted. While such an analysis is being made there occurs a reorganization or reconstruction of the details or features in new relations.

Differentiation may be illustrated by an example. When one approaches a particular spot in a field of vegetation he perceives the general character of the situation as an undifferentiated whole; he perceives the general outline and color, but he may not clearly distinguish the individual plants. As he comes nearer and observes carefully, the outlines of individual plants begin to appear, and they stand out against the background as a whole. Eventually the observer may single out one plant for special study. At first he may note its general form, arrangement, and color. As he studies the plant further he notes the characteristics and relationships of the parts, perhaps in great detail, depending upon his purposes. Such differentiation of the parts is the first step in interpretation.

Along with the differentiation of sensory experience there occurs a selection; some of the items receive attention, others are neglected or disregarded. Sometimes it is not easy to neglect the useless items, but as one continues his perceptual learning he acquires added facility in discarding that part of sensory experience which does not serve his purpose. I well remember that when I began to wear glasses I was much annoyed by the reflection of objects and occurrences behind me. Within a short time, however, they no longer bothered me; I was not aware of them. In all perceptual learning one selects out of situations those aspects which serve his purposes and disregards the others.

A further word should be said about the highly important process of differentiation. Apprehension of the whole, without distinguishing details and their relations often has only very limited value. As an example we may revert to the illustration just used. The pharmacognosist is likely to have more concern with the individual plant or plants than with the whole situation. Furthermore, his primary concern may be with one aspect of the individual plant or plants.

A further example is seen when one approaches a city from a distance. At first he sees the general skyline but does not distinguish clearly the individual objects. That is useful for the time being, but it is not sufficient for him to accomplish his purposes in the city. As he nears and enters it he has to distinguish certain streets and buildings, and his primary concern tends to be with them and their relations to one another and to the city as a whole.

Thus, in learning about objects and situations the learner analyzes their salient features and thereby obtains more precise and complete knowledge. The extent to which such differentiation is necessary depends on the purpose of the learner.

Let us look briefly at the reorganization or reconstruction that occurs in perception and perceptual learning. One sees an object that is new to him, and he may be told it is a papaya. He acquires a general notion or idea of it, sufficient perhaps to enable him to recognize another papaya when he sees one. But that may not be sufficient for his purposes, so he proceeds to examine the papaya, noting its form, size, color, character of the skin, weight, odor, taste and many other characteristics. Perhaps he dissects the papaya and studies the characteristics of the inside. As he proceeds with his observation there occurs an intellectual reorganization of his sensory experience, and the meaning of the object is greatly enriched for him. He combines into an orderly whole a number of present sensations with contributions out of his previously acquired knowledge. Through analysis and reconstruction of the sensory experience he has engaged in perceptual learning. Thereafter a papaya is more than merely a small object such as he saw at first.

Eventually in the course of his learning the learner may reach the point where he is able to perceive or recognize the object or situation by noting one or a few of its characteristics (which serve as cues), as when he recognizes a papaya from its color, its form, or its odor. So one may recognize John Jones from the sound of his footsteps, timbre of his voice, or the form of his gait. The skilled physician frequently diagnoses a pathological condition at first sight merely from the presence of one or a few signs.

The interpretation of sensory experience that one makes in perceptual learning depends in part upon his fund of knowledge and his ways of thinking. The new is interpreted in the light of what one has previously learned. Where adequate knowledge is lacking, the interpretation becomes partial, distorted, inadequate, perhaps entirely wrong.

One's "mental set" at the time also helps to determine what and how much he will perceive. His intent, purpose, or desire play a large part in directing the course of perceptual activity. In addition to having these temporary mental sets, a person has also more prolonged or permanent mental sets. One's hobby, vocation, religion, political affiliation, and so forth, give him prejudices and biases that may exert powerful influences in his interpretation of an object or situation.

Related to the idea of the mental set is the fact that objects and situations that are known to have much significance for one are likely to come vividly to his attention and to be perceived quickly. The sound of an explosion nearby, the rustle of a snake in the grass, the odor of escaping gas, and the growl of an angry dog receive immediate attention because of their possible consequences. The competent physician will almost at once perceive the danger signals in the condition of his patient and act accordingly.

Report in Perceptual Learning

It is well recognized that the reporting of perception promotes perceptual learning. It affects the observation by enforcing attention to details and relations. It is said of the famous Harvard teacher of biology, Louis Agassiz, that he once remarked, "A pencil is one of the best of eyes." Reporting by the learner also enables the teacher to check on the accuracy and completeness of perception.

The report of perception depends upon two factors: the perception of the object or situation and the ability of the reporter to express the perception in some form such as words, drawings, and models. In case the reporting is done in the absence of the object or situation, memory also becomes a factor.

Verbal reports may be given in a narrative or an interrogatory form. In the narrative report an account is given voluntarily (without questioning) on what has been observed. In the interrogatory report the reporter answers a series of questions covering the object observed. The form— narrative or interrogatory — affects the range and accuracy of the report. In an interrogatory report the types of questions used influence the accuracy of the replies.

Studies reveal the fact that reports of observation are almost never free from error. Even reports made by specially trained observers are seldom entirely accurate.

Training in Perception

Perceptual learning, like other types of learning, can be stimulated and directed. Without considering this matter at length we may comment on a few features.

We should note that training in perception, to be most effective, should

be specific. The artist-painter becomes highly competent in perceiving objects, but he does not thereby become skilled in perceiving rhythm, melody, and harmony in music, or competent in perceiving the condition of one who is ill.

Education aims at developing perception of certain things rather than at improving perception in general. For example, if one desires to improve his perception of the materials used in pharmacy he would not practice on perceiving landscapes, buildings, and other unrelated objects and situations. Likewise it would not be sound educationally to spend time in the study of pharmacognosy merely on the ground that it may sharpen his perception of other materials.

As has been indicated, perceptual learning involves both sensory experience and interpretation of that experience. After the years of infancy improvement in perception occurs almost entirely through improvement in interpretation in the form of analysis and reconstruction. The Indian in the forest, for example, traces his way much more easily than the unskilled woodsman, not so much because he has more acute sensory experience (he is probably no more clear-sighted than anyone else), as because he knows the signs to note and what they mean. Likewise one person sees a postage stamp and notes an astonishing number of details because he knows much about postage stamps. Another hears a melody played by an orchestra, recognizes what the melody is, indicates the key in which it is played, and notes errors in the performance. It follows then that perceptual learning goes forward primarily as one acquires the mental foundation for interpreting his sensory experience. This foundation consists of knowledge, ways of thinking, and skills in doing things. The accumulation of such attainments is essential to the improvement of perception.

Directed observation and guidance is helpful for students engaged in perceptual learning. It may take several forms. The teacher may give oral directions as to what students shall do. In the presence of objects or situations he may point out verbally and directly (with a pointer) the features to which particular attention should be given. Directions may be in the form of writing. Check lists of things to be observed, observational outlines, and questions directing attention to essential features of the objects under observation are invaluable to the student.

Students can be given a plan of procedure for making their observations; it is one thing to look haphazardly at an object, a situation, or a demonstration, and quite another to explore it systematically and for a definite purpose. The task of the teacher is hardly ended by the simple instruction to the student that he should observe with care. In all his instruction the teacher needs to avoid telling students too much; the learning exercise should not become a mere "cook-book" activity with little or no thinking and activity on the part of students. Frequent tests of what students have learned through their observation usually stimulate better work on the part of students and thereby result in improvement.

Favorable Conditions for Perceptual Learning

Perceptual learning is facilitated by favorable surrounding conditions. For visual perception the objects and situations should appear under favorable illumination, and they must be well within the range of vision. For auditory perception the sounds must be audible. An occurrence should be presented slowly and repeated as often as necessary. In observing a situation involving motion, it is usually not possible for the observer to take in all aspects unless the speed is reduced. One observation is seldom sufficient for the learner to obtain a clear idea. So far as possible, the particular feature or features to be observed should be isolated. For this purpose a diagram has advantages over a picture with many details.

In order that there may be the greatest improvement in learning through direct contact with objects and occurrences, teachers should deliberately provide or create good learning situations. Such situations include demonstrations, laboratory exercises, and field trips. Each of these situations serves definite purposes in teaching.

Let me say here that there are three general types of laboratory exercises. The information type consists largely of observing phenomena as they exist. The dissection exercise is an example. The aim is to acquire firsthand or perceptual experience with objects and operations. The experimental type of exercise provides data for use in verifying hypotheses in solving certain types of problems. It is closely related to research. However, for almost everyone except the professional scientist or one who aspires to that profession, the experimental exercise is only a means of learning; it is seldom a method of discovery in science as a school subject. The learning may be original for the learner, but it is not original for mankind. For the student it reinforces information already recorded on the printed page. The technic type of exercise is one in which the student learns to perform certain operations that are of practical use and develops skill in them. It is a significant means of learning in several professional fields such as dentistry and pharmacy.

For certain purposes the demonstration by the teacher is a better means of learning than is the laboratory exercise performed by the student. It combines both language and sensory experience, usually visual sensation, explanation being given at the time the observation takes place with each reinforcing the other. The demonstration is more economical in time, effort, and expense than the laboratory exercise. Moreover, to create certain learning opportunities or situations often requires difficult construction and manipulation which in themselves are not important for students to learn; where that is the case it is better to employ a demonstration by the teacher than a laboratory exercise performed by the student. I would also call attention to the fact that the demonstration has some limitations as a means of learning.

Field work in natural science provides the basis for direct study of the nature, activities, and interactions of the numerous components of natural

and man-made situations. It is useful in practically all branches of science. Professor William H. Weston, of Harvard University, comments as follows on the outstanding advantage of studying biological material in relation to its surroundings:

"In the ecological aspects of biology, for example, field work demands consideration of trees not as mangled remnants of a branch with a few leaves and buds, or of a trunk or root cut in transverse, radial, and tangential sections, but as a complete and living being, growing in characteristic stands in complex interrelation with the many plants and animals that are the living components of its environment, and with the sunlight, rainfall, wind, temperature, soil, and other nonliving factors of its surroundings. Similarly it vividly impresses the student with, let us say, a fish not as a drab and dismal specimen gazing with an alcoholic leer from a dusty jar, but as a vital creature with a life of activity that is closely inter-related with the aquatic plants that furnish shelter, the living things that serve as food, and the water that supplies or denies the dissolved air necessary for respiration." (In A Handbook for College Teachers, by Bernice Brown Cronkhite, Harvard University Press, Cambridge, Mass., 1950, p. 117.)

I still have a vivid memory of a field trip taken when I was a student in a course in physiography 40 years ago. The college was situated on a terminal moraine. The class went to a gravel pit where materials were being excavated for road and building construction. The instructor pointed out the different types and arrangements of the materials and he explained how the deposits varied because of the rate and direction of the flow of the water which laid them down. No other form of instruction could possibly have resulted in the clear learning we had that day. Now every time I see a bank of gravel I have an appreciation and understanding of its meaning.

Kinds and Extent of Reporting

I have previously indicated that reporting by the student promotes perceptual learning. The need for reports and records varies with the type of exercises that are used. Verbal reports, drawings, and models are the most common means of reporting.

In exercises in biological subjects it is customary to require drawings or some other indication of what has been observed. Drawings may indicate quickly and definitely what the student has noted. There seems to be no doubt that diagrams or simple sketches of things observed are better from an educational point of view than are pictorial drawings with many details. For most students the effort required to make pictorial drawings is out of all proportion to the educational values obtained therefrom. Diagrams should represent essential features but little else. It is a common practice in chemistry, physics, and mechanics to require only a brief record of data taken down as the observation goes on.

In certain subjects teachers often have students make models of things observed. Teachers of dental anatomy, for example, require students to

carve teeth from plaster or wax primarily to assist in acquiring knowledge of tooth form. The principal objection to making models as a means of reporting is that it is very time consuming.

Reports of observations should be regarded in the same light as notes made from reading or listening to a lecture. They are materials to be used in thinking. How extensively students should be required to prepare formal reports on demonstrations, laboratory exercises, and field trips is a subject you may wish to consider during the discussion period.

Audio-Visual Aids in Learning Science

We began this discussion by noting that the elemental facts of science are acquired through three means, and we have considered how we learn through direct experience with objects and situations. One's store of knowledge is also greatly enriched through the use of audio-visual aids, among which are pictures, stereographs, drawings, maps, globes, charts, diagrams, and models. Through them opportunities can be provided for repeated observation of many complex patterns of the objective world. Learning through them is largely a perceptual process, and the principles of perceptual learning previously explained apply to the use of these representative materials as well as to the use of objects and situations.

Audio-visual aids are particularly useful in learning about objects and situations with which the learner cannot have direct contact or experience. Through them, particularly still and motion pictures, the whole world can be brought vividly to the student. I mention again the course I once had in physiography. The instructor had numerous lantern slides of a great variety of physical phenomena in all parts of the world, and he knew how to use them with telling effect. His illustrations of various forms of weathering and erosion, for example, were an eye opener to all of us who sat at his feet.

Usually audio-visual aids are not as effective as the objects or situations they represent. Surely a student would learn more from an actual specimen of a butterfly, for example, than from a photograph or a model. On occasion, however, the visual aid may prove more effective, as when a motion picture is shown in slow motion to enable one to analyze motion that is naturally too rapid for the unassisted eye to see the parts or phases. "Close-ups" of motion pictures are also of much assistance to the learner for they serve to magnify the sensory experience so it may be more readily perceived.

Audio-visual aids may be overused and misused. When that occurs they may promote less active learning in which the student just sits and looks, becoming a receptacle of instruction and reverting to a status of somnolent inactivity. Such a state of affairs can be avoided by exercises in which the student participates, such as discussing and reporting on what is observed.

The extensive use of audio-visual aids as well as direct sensory

experience with objects and situations may overemphasize perceptual learning and the mere acquisition of factual information. The learning of science involves more than the accumulation of knowledge; the learner should attain increasing intellectual power through the classification, organization, and generalization of ideas, and the solving of problems. These intellectual activities go far beyond perceptual learning.

Language in Learning Science

Up to this point we have been dealing with the learning of science largely through direct sensory experience with objects and situations and through sensory experience with representations of such objects and situations. We need now to note that a vast body of the knowledge of science is made available to the learner through spoken and written language. How to get the most out of what persons and printed matter communicate to the learner is an educational question of great import. It involves two learning activities: reading and listening. A student of science who is not adept at both is greatly handicapped indeed.

We may note here that a very large and significant part of the process of learning a science consists of learning the language of the science, for the student a new and highly specialized language. He is required to enlarge his vocabulary with a sizable number of scientific terms and to attach new and specialized meanings to many ordinary and common terms. He hears and reads these terms as they are used in sentences to express numerous scientific relationships, propositions, and principles. He learns to understand the terms with intentional exactness as they are used to convey the meaning, the whole meaning, and none but the correct meaning. Truly, the learning of the language of science is then a clear necessity if one wishes to benefit fully from communication with scientists.

How does the student learn scientific language? That would be a subject for profitable discussion if there were time for it. Until now we have been considering learning through language, principally from the point of view of what one receives through communication from others. We need also to note the effect of communication upon the communicator. It is a common experience that as one expresses his thoughts in language they become clearer and more definite to him and that the process leads to deeper insight and fresh discovery. What teacher has not been thrilled because he learned many new things as he explained his subject to students or committed his knowledge to manuscript.

The reason why such learning occurs is not difficult to understand. When one prepares to explain a topic, he collects his information from various sources, frequently a bit from here and another from there, and often in a none-too-systematic way, but when he gives the exposition he arranges the ideas in logical sequence so they are easily followed. Thus, through exposition the expositor's ideas are clarified and enlarged.

Another aspect of learning by explaining to someone is well stated by Gardiner when he says:

" In his effort to influence the mind of others, man has learnt to instruct his own. Whilst elaborating a sentence the speaker does not completely divest himself of the receptive learning attitude which alternates so regularly and easily with his creative role as speaker. He is, in fact, always a fellow-listener, and hence also a fellow-learner." (Alan H. Gardiner, The Theory of Speech and Language, p. 326. Oxford: Clarendon Press, 1932.)

No doubt you know that a cardinal feature of the tutorial instruction so well employed at Oxford University is the weekly theme or paper which the student brings to the conference with his tutor. By writing out his ideas the student learns to think as well as to use language. I am satisfied that in our own educational practice we do not sufficiently emphasize learning through both spoken and written expression of ideas. In the learning of science we are particularly guilty of this omission.

Besides serving as a medium of communication, language has another very significant use in learning: it becomes a vehicle through which mental activity is carried on and organized. Labels are of definite assistance in making fine distinctions, in clearing up dim and vague experience and making it condense into definite form. Language is also of great importance in acquiring, organizing, and conserving meanings. It would be almost impossible for one to deal w th abstract concepts without the use of language. Between language and thought there is a complex interaction; language facilitates thinking, and thinking refines the language of the thinker. It has often been said that an idea does not become entirely clear and usable for an individual until he has expressed it in some way, usually in linguistic form.

Every observant teacher knows, of course, that the learning of language by no means assures comprehension of the ideas for which the language stands. Students will sometimes use the words of a book, even strange and scientific words, with ease, but when pressed for an explanation or an example of what they are talking about they are lost. Obviously such superficial verbalism is of little or no use in thinking.

These facts concerning language in its relation to communication and thinking suggest the significant role it must have in the learning process in science.

In Conclusion

You will recognize that this address is but a partial statement concerning the learning process in science. It has attempted to deal with only certain aspects of the question and has made little reference to such matters as memorizing, reasoning, the solving of problems, and the transfer of training.

May I say in conclusion that in my opinion every teacher should inform himself concerning the learning process. I am certain that a teacher's service will be improved if he makes an effort to find out how his students learn and if he will then organize and manage his teaching in accordance with that knowledge.

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Methods for the Orientation of Students in Pharmacognosy
(A Panel Discussion)

Dr. M. R. Gibson
Washington State College

I found it somewhat of a paradox that I should be asked to serve on a panel dedicated to the purpose of discussing orientation methods. I found it paradoxical because orientation lectures are the very ones I dislike most heartily to give! An examination of the reasoning for such an aversion led me to the conclusion that it is because the students are not oriented mentally to me, nor I to them. Therefore, I should like to discuss orientation in a broad sense, mainly, the orientation of a new mind, the student's, to a new facet of his education, here pharmacognosy--an orientation which is not accomplished in the first few lectures, but is a vital, growing thing and a continual process throughout the course. Possibly my colleagues on the panel will discuss the more specific aspects of introductory lectures.

To many professors the raison d'etre is simply the transmission through their discipline of all of their own awareness of the best that they know. Yet, too few realize that in this transmission they fail to accomplish the desired ends because of an improper mental rapport with the student. The student's factual and mental concord, discord, or even torpor is the difference between the student's enthusiastic cooperation, discouragement, antagonism, or possibly apathy. The obvious result for the student is progress or passivity.

A new group of students represents an unwieldy mass of heterogeneous minds and attitudes which must be molded to factual material and inspired to learn. I should like, first, to deal briefly with the presentation of the subject material and then to digress to the more abstruse, inspirational aspects of the problem. We in pharmacognosy are endowed with a mass of factual material which has accumulated like a stalactite--and some of it is just about as useless. Too many of us are too concerned with presenting subject matter is a systematic way instead of inducing students to think for themselves and to think responsibly. We must remember that successful teaching is getting students to learn, not getting them to parrot masses of factual information. A desire to learn is imperative; a desire which must be stimulated to be maximally productive. And it is this impetus that is the true, basic orientation of the student's mind. In pharmacognosy there must be the subtle correlation by the instructor of basic scientific concepts, proved specific scientific facts, and current interest trends. A student must be attuned to a subject from those things which are of interest to him, made aware of the facts that he must know concerning specific drugs, but always kept mindful of the basic principles of general application which make a particular drug part of an entire group with common properties.

An instructor must be sufficiently creative to enlarge and make even more meaningful the knowledge he possesses. He must be able to perceive in press releases, and in popular and scientific periodicals, correlations with his subject field and to integrate current interests of the students with the core of information

being presented--an effective bridge which the student eventually must make if he is to use his education as a nucleus for a lifetime of self-education. This integration of the current with regular subject matter is often the vitalizing factor that orients the student' s mind to a desire to learn and thus determines the success or failure of instruction.

Therefore, the first tenet I submit in the orientation of a student is the presentation of factual material by way of student interest routes, the success of which may be directly proportionate to the ingenuity of the professor.

The orientation of subject matter to student receptivity is a concrete thing. But to quadrate the mind of the student fully with the subject matter he must be in complete mental rapport with the instructor on a general as well as a subject level. Conformity of attitude toward subject matter is that almost undefinable something that makes the difference between simply a teacher and an outstanding actuator of student thinking. To accomplish this the instructor must not simply be seeking to make clear the tested and proved accumulation that is embodied in his discipline, but must be interested in the material being presented, enthusiastic over the qualities, significancies, implications, and potentialities being interpreted. He must reveal with animation and sincerity because he thinks and feels very keenly about the material. He must have a spark, an enthusiasm, animating the projection of his personality and the facts into student minds. Vital intellectual energy must be inspired; and the center of individual interest, zest, and enthusiasm must be reached and stimulated. The teacher of pharmacognosy must also see that the material offered is retained in a catalyzed state so that the material given is not simply taken up and stored but is retained in a vitalized form impregnated with the awareness of its accessibility.

To accomplish this goal the instructor must be continually adding to his own effective knowledge, increasing his skills, and stimulating his interests and enthusiastic drive. An instructor who accomplishes this enjoys with his students a mutually stimulating experience of mental growth and satisfaction of personal attainment.

These tenets I project as the true methods of successfully orienting the student to pharmacognosy: the vitalizing of the field brought about by the sensitivity to, and concern for, the creation of more prepossessing aspects of the field; the encouragement into the instructional field of those individuals who possess, or have the potentialities to possess, a Promethean fire of intellectual inspiration.

Methods for the Orientation of Students in Pharmacognosy

J. Allen Reese
University of Kansas

During the past twenty years I have tried many approaches in an attempt to orient students in Pharmacognosy. None has been entirely satisfactory to me. The reaction of the classes has been so different that I have changed my method of approach to the class several times during a semester.

It would appear self evident that a student interested in Pharmacy is interested in drugs, and Pharmacognosy is the study of vegetable and animal drugs. If we assume the above statement is true, the problem can be stated simply: Find the approach which stimulates the students' interest. The answer, however, is not so simple.

It has seemed reasonable to me that the logical introduction to the study of Pharmacognosy should be an historical one. In my own opinion I have failed miserably in trying to use this approach. I still firmly believe that the only way to really appreciate the present status of the vegetable and animal drugs is to know their past history, but I have stopped trying to do this at the beginning.

I try to have students cognizant of these facts:

That many sciences are represented in the various steps involved in the preparation of the final drug product used by the patient.

That the artificial lines which separate the many branches of science are not too sharp and that these lines of demarcation are in many cases arbitrary ones.

That the important point for the student to remember is that he should get a broad knowledge of drugs and their application.

That the question of what is important and what is not important is a relative one, for what is considered very important today may be considered insignificant in a few years.

That facts never change but man's ideas regarding their interpretations do.

That the use of drugs is subject to the whims and fancies of man and certain ones go through cycles of popularity similar to women's clothing.

I sometimes illustrate the cycles through which a drug passes using Digitalis as an example. The same drug is also useful in illustrating the many ups and downs and false leads in trying to make available the constituent which represents the medicinally useful portion of Digitalis. I emphasize that it is much more important to have knowledge concerning drugs than to

know specific things about a particular drug. Any drug may disappear from the physician's armamentarium. When new information is obtained about a drug this may modify our opinions concerning it. This information may be exploited for financial reasons. A drug may lose popularity because of unfavorable publicity which may be entirely or partially false. A drug may have popularity out of all proportion to its true usefulness when this is finally ascertained. A substance may be considered a quack medicine by a consensus of medical opinion at the time, and later be recognized by all reputable physicians as a valuable medicinal agent. This happened to compressed yeast which was advertised in the 1920's as recommended by a Vienna specialist in the treatment of various skin conditions. Physicians of the era smiled at the exploitation of this worthless product. Since the discovery of the vitamins present, no reputable physician doubts its value when these vitamin deficiencies are present.

How can we judge whether or not a drug is important? To S. B. Penick and Company, corn silk, red clover blossoms, or some similar substance may yield a greater financial return than Digitalis. To a physician the drugs which he prescribes are the most important.

Few, if any, would doubt that sources of information are very important. I have given lectures on books and journals relating to the field of Pharmacognosy before beginning the study of drugs. This did not prove satisfactory to me and I now refer to these sources of information at various times when considering the individual drugs. Few students use references voluntarily and I have found it necessary to use compulsory methods. One or two students out of each class may be stimulated by a chance reference to some book or article and I try to remember these unusual students. Generally, the latter are our potential graduate students.

Some of the many things which are not known about drugs are mentioned. No one lecture or discussion is devoted to this, but from time to time the limitations of our knowledge are pointed out. That there can be honest differences of opinion concerning available information is thereby admitted. The opinions of individuals should be considered in the light of each one's background of knowledge of the subject. "Today man can discover his errors of yesterday and tomorrow he may obtain a new light on what he thinks himself sure of today."

There are several systems of classification of drugs. Each may prove useful for some purpose and a student may find it helpful to use more than one system in his study. All systems have their limitations and should be used when they assist the student in his study. Most students can acquire information about drugs better and retain it longer by considering drugs in classes or groups. Similarities are useful since they enable one to make use of association of ideas. Differences, however, are sometimes more important from the standpoint of identification or the critical evaluation of a drug. "The true order of learning should be first, what is necessary, second, what is useful; and third, what is ornamental. To reverse this arrangement is like beginning to build at the top of the edifice."

There is more to pharmacognosy than the learning of so many points about each drug, just as there is more to organic chemistry than a number of formulas or to biochemistry than memorizing the structure of 25 amino acids. Pharmacognosy is a living science which makes use of biological material as well as the inanimate chemicals which are constituents of vegetable and animal drugs. Some of the aims of pharmacognosy are: uniformity in obtaining the best drug that is practical; improving the quality of the drug; understanding what it is that makes a drug useful in the practice of medicine; understanding the properties of the drug so that it may be handled most advantageously; the discovery of new, useful drugs.

In order to fully realize these aims, much more fundamental knowledge is necessary than is known at present. Hence, research of a fundamental nature should continue to be carried on.

Much of our knowledge of drugs has been obtained by empirical methods. We do not know enough to prove or disprove some of the things we believe to be true. Re-evaluating what is thought to be true is a continuous process.

Almost every drug has a fascinating history; however, most students must learn a few things about a drug before they can become interested in its past. Unless a student can associate facts with the name of the drug, numerous details are meaningless. Therefore the name of the drug must cause the student to form some type of mental picture. This, in my opinion, is the best justification for the identification of drugs. It is in my opinion practically an impossibility for anyone to learn to identify a drug by name and not learn other information about the drug. I believe students should be apprised of why they are taught to identify drugs if this method of approach is used. If there is no further justification for a procedure than, "that is the way it was taught to me," another method should be developed.

I am enthusiastic about Pharmacognosy and I want the students to know this. New discoveries in the field thrill me and I believe some of my students become at least slightly enthusiastic. The hopes and accomplishments of men in the field may have a stimulating effect on some of the students, particularly if these can be linked to recent achievements. There is something fascinating about anything new whether it is of much importance or not.

I believe it can be seen from the foregoing that my method of orientation is a continuing one throughout the course and not a series of lectures at the beginning. The details are constantly undergoing changes, but the fundamental attitude remains the same.

Orientation in Pharmacognosy

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A common practice in teaching is to proceed from the general to the particular and my remarks concerning the student's orientation in pharmacognosy follow this practice.

First, to be very literal: to orientate means to face or point toward the east, whence comes the sun; or, to the crystallographer, orientation means placing a crystal so that its axes, etc. assume their proper position in respect to the observer. In any course or new subject of the curriculum, then, we may think of orientation quite literally as a directing of the student toward sources of illumination and also as presenting the subject in such a way that its inherent and fundamental characters assume their proper relations in the student's learning. Orientation, therefore, should be a continuing procedure and not a matter for discussion solely in the early part of the course.

The question of student motivation looms large in all teaching and an orientation program can contribute to this aspect of learning (1) by making the subject more meaningful, (2) by developing a knowledge and appreciation of the ultimate goal of the course, (3) by periodic evaluation of progress toward the goal.

Since learning involves, among other things, an achievement of new, meaningful relations by organization (or reorganization) of past knowledge and experience, the starting point for the course and its orientation program is set by the level of attainment reached by the class.

Now, to pass along from these general statements and premises and to indicate how they are applicable to orientation in pharmacognosy. I want to touch on relationships, correlation, course scope and objectives, and sources of information as phases of the orientation program.

Relationships:

In beginning the course it is important to point out to the student the relationships between pharmacognosy and other courses of the curriculum and to show him which other sciences and studies contribute to pharmacognosy. The diagram and tabulation will assist in making this clear. A logical sequence in the curriculum will aid greatly in helping the student understand the connections which pharmacognosy has with those courses leading to it and those stemming from it. And with an appreciation of pharmacognosy's position and role it will be easier to subsequently develop the necessary correlations and fundamental background which the pharmacist can utilize in his daily practice.

I believe it is important to stress the fact that the special contribution of the pharmacist to the other health professions is his knowledge of the properties

and uses of drugs and that pharmacognosy is the study which deals with all the essential characteristics of drug materials of biologic origin excepting, of course, their mode of action, which is the province of pharmacology. To point out that the core of his professional studies consists of subjects applicable in pharmaceutical processes or subjects concerned with pharmaceutical materials will serve to increase the student's awareness of the basic importance of pharmacognosy, since so many of the medicaments he will dispense are products of biologic origin.

Correlation.

The ultimate application of some pharmacognostic knowledge by the dispenser at the prescription counter is based on an integration of many different sciences. New facts presented in the pharmacognosy course should be correlated with the basic knowledge the student already possesses from his previous study of biology, chemistry, pharmacy and other courses. The student should be advised that the information presented in pharmacognosy is not to be tucked away in a mental pigeon hole labelled "pharmacognosy", but is to be used in furthering his understanding of subsequent studies and broadening his familiarity with drug substances.

Certainly to as great an extent, if not to a greater extent than in any other course of the curriculum, pharmacognosy provides the opportunity to correlate, to integrate in a unified whole, the various bits and kinds of information secured in other courses. To advise the student that he will be introduced to aspects of economic botany, to phases of commerce, to historical events and colorful personages - that a kaleidoscopic view of human culture will be unfolded in pharmacognosy - serves to arouse his curiosity and sense of adventure.

Scope.

When beginning the course the scope and general plan of the basic course in pharmacognosy should be outlined to the class. This may be done by distributing a syllabus or a sequential outline of the topics to be considered and the laboratory work to be carried out. The very broad scope of pharmacognosy as a science may be reserved for later presentation, but its applications to the production, qualities and uses of selected drug materials should be indicated early in the course.

In discussing the scope of the first course it is worthwhile to emphasize that principles and fundamental considerations are of preëminent importance and that a relatively small number of drugs will be utilized to illustrate them. Likewise, it should be pointed out that later on (e.g. second semester) applications of the basic principles will be made to a much larger number of drugs.

Objectives.

The formation of clear and definite objectives for the course is most important to the orientation program. Requiring the student to keep these objectives readily available for repeated reference (e.g. in the front of his

notebook) increases his awareness of them. To set up these guideposts at the beginning of the course and to have the student periodically check his progress toward the goals will not only increase his awareness of the objectives but will help him to develop the desired appreciation of the ultimate aims of the course.

This meeting has already discussed what the objectives of the pharmacognosy course should or might be. Each teacher will make a decision about which objectives to set up for his own course. The point to be stressed now is that these objectives be made known to the students and that, as a continuing phase of the orientation program, they be referred to frequently during the course.

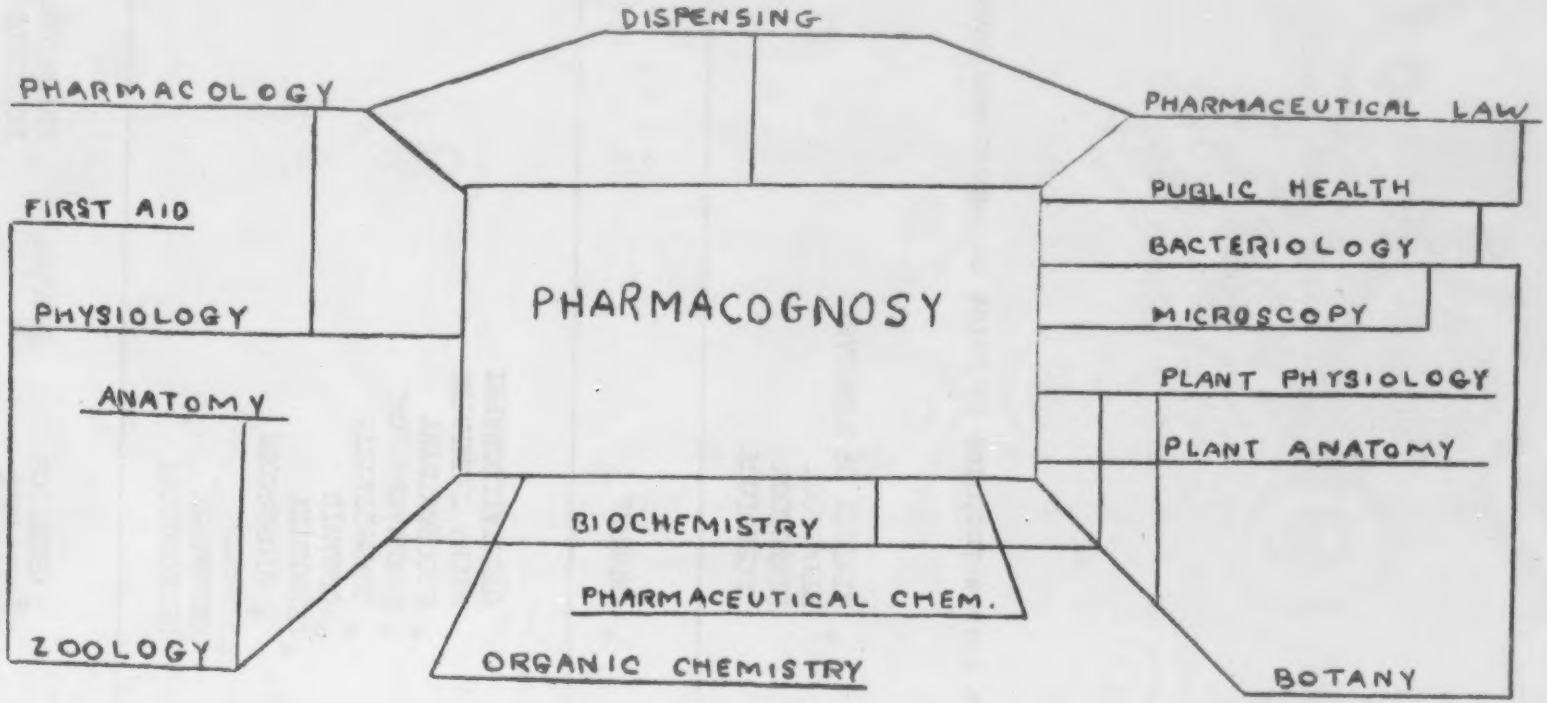
Sources of information.

As a common meeting ground for many sciences pharmacognosy employs techniques and embraces principles and learning from many scientific fields. Sources of information pertinent to pharmacognosy, therefore, cut across numerous sciences.

The student's first source of information is the textbook designated for the course. References cited by the textbook should be augmented by the instructor's selection of supplementary sources. Such direction of the student to other textbooks, to periodical literature and to reference works available in the library will serve two purposes. It will add to his appreciation of the various ramifications and relations of pharmacognosy and will help him correlate his pharmacognostic learning with his knowledge of other sciences. Also, it will increase his general familiarity with the literature of his profession.

What can be done in this direction will, of course, be influenced by how well the class can use the library as a working tool. When the instructor can base this phase of orientation in pharmacognosy on previous class instruction on how to use the library, he has much greater latitude. Interesting and challenging questions can be assigned for individual, group or class study.

I have purposely omitted any comments concerning introductory explanations to the class about details of arrangement of course requirements, examinations, notebooks, etc., etc. However, as a final comment, I think it is desirable to emphasize to the class that only the high spots of the subject will be presented - the low spots are to be dug out by each student. The rich mental food of pharmacognosy will be spread before them - they are expected to help themselves. The task of the teacher is to guide and help them - to assist in selecting from the bounteous table of pharmacognosy.


DISPENSING
PHARMACOLOGY
PHARMACEUTICAL LAW
PUBLIC HEALTH
FIRST AID
BACTERIOLOGY
PHARMACOGNOSY
PHYSIOLOGY
MICROSCOPY
PLANT PHYSIOLOGY
ANATOMY
PLANT ANATOMY
BIOCHEMISTRY
PHARMACEUTICAL CHEM.
ZOOLOGY
ORGANIC CHEMISTRY
BOTANY

PHARMACOGNOSY
ZOOLOGY
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ORGANIC CHEMISTRY
BIOCHEMISTRY
PHARMACEUTICAL CHEM
BOTANY
PLANT PHYSIOLOGY
MICROBIOLOGY
PUBLIC HEALTH
PHARMACEUTICAL LAW

BIOLOGICAL SCIENCES (BOTANY & ZOOLOGY)	* TAXONOMY * MORPHOLOGY * ANATOMY * HISTOLOGY * PHYSIOLOGY * GENETICS	BOTANY AND ZOOLOGY	* MYCOLOGY * BACTERIOLOGY AGRICULTURE PATHOLOGY * ECOLOGY ECONOMIC BOTANY ENTOMOLOGY
PHYSICAL SCIENCES	METEOROLOGY GEOGRAPHY * PHYSICS * MICROSCOPY * CHEMISTRY * ORGANIC * QUANTITATIVE * PHARMACEUTICAL * BIOCHEMISTRY MICRO CHEMISTRY CRYSTALLOGRAPHY		
ECONOMICS	* GENERAL		
HISTORICAL	ARCHEOLOGY ETHNOLOGY ETYMOLOGY * HISTORY OF PHARMACY		

* Subjects or phases included in prior or concurrent courses

* Subjects or Papers Included in Prelim or Comprehensive Courses

Belladonna from the Taxonomic Viewpoint

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In the method of presenting Belladonna according to the taxonomic or botanical classification of vegetable drugs, the drug is considered under the Family Solanaceae whose general gross and histological characteristics are presented immediately before taking up the drugs belonging to this family. In learning the outstanding features about the Solanaceae or Nightshade Family one gains a bird's eye view of what to expect in one's later study of the various organs, tissues, cell contents and active principles represented among the drugs in the group of which Belladonna and its products are the most widely used in therapy today.

The word Belladonna is derived from two Italian words (bella, beautiful, and donna, lady, and alludes to the use of its fruits by the Italian ladies of earlier periods for dilating the pupils of their eyes, so improving their appearance.

The entire plant, Atropa Belladonna L., is employed for the extraction of alkaloids, and all of the plant excepting its thicker stems over 10 mm. in thickness and its woody root crowns is officially recognized under two monographs viz: Belladonna Root, N. F. and Belladonna Leaf, U. S. P.

Plant: Atropa Belladonna, commonly known as Deadly Nightshade, Dwale and Black Cherry, is a perennial bushy herb native to central and southern Europe and northern Asia Minor, and naturalized in the United States where it has long been cultivated as an important drug crop. The Belladonna plant produces a root system consisting of a dense cluster of fleshy conical roots and a crown (rhizome) from which arises one or more dichotomously branched stems bearing numerous dark green leaves and later, flowers and fruits. The leaves are alternate below and in pairs above, one leaf of the pair being larger than the other. They are petiolate with an ovate to broadly ovate blade possessing an entire to nearly entire margin, an acute apex and a tapering base. The flowers are mostly solitary but occasionally in axillary cymes of 2 or 3 flowers which come off between the pairs of upper leaves. Each flower consists of a deeply 5-cleft calyx with triangular-acuminate lobes, a tubular campanulate corolla with 5 shallow, spreading to recurved lobes which is dull reddish-purple tinged with pale green in the lower part, 5 epipetalous stamens shorter than the corolla, a bicarpellate pistil with exserted style and capitate stigma. The fruit is a fleshy, globular, depressed, black, 2-celled berry, umbilicate at its summit with a persistent calyx. All parts of the plant are poisonous.

BELLADONNA ROOT (BELLADONNAE RADIX) N. F.

Official synonym: Deadly Nightshade Root

Belladonna Root consists of the dried root of Atropa Belladonna L. which yields not less than 0.45 per cent of the total alkaloids of Belladonna Root.

Each student is provided with a representative sample of unground Belladonna root, a small sample of powdered belladonna root, cross and

longitudinal sections of Belladonna root and cross sections of Belladonna stem, also transverse and radial-longitudinal sections of Poke root, the chief adulterant. In the lecture the diagnostic features of the unground drug and powdered drug, the constituents, uses, and official preparations are taken up. All of the histology is given in the laboratory. There the student compares the physical characteristics and diagnostic histological characteristics of Belladonna and Poke roots (as seen by the examination of slides of sections and mounts of powdered material under the microscope). As the student examines his materials the teacher at the rostrum directs each phase of the examination and illustrates with blackboard sketches and charts. The student compares his materials with descriptions of the drug and Poke root in the text and makes sketches of salient microscopical structures observed which are called in for examination and grading by the instructor.

Physical characteristics: Unground Belladonna Root occurs in cylindrical or somewhat tapering segments of roots which are frequently cut longitudinally and often with a few stem bases. The roots are weak brown to moderate yellowish brown and longitudinally wrinkled, the periderm being frequently abraded in places. The fracture is nearly smooth, mealy, emitting a puff of dust. Internally, the drug shows a pale yellow to yellowish brown color, a very distinct cambium line, and yellowish wood wedges. It is nearly inodorous. Its taste is sweet, afterwards bitter and strongly acrid. On boiling, the root possesses a peculiar, strongly narcotic odor.

Histology: The diagnostic histological features of Belladonna Root in cross section are as follows: The secondary cortex consists of a variable number of layers of cortical parenchyma cells most of which are filled with starch. Scattered amongst these are cells of grayish or black aspect which contain micro-crystals. The phloem is devoid of phloem fibers. The xylem is composed of radially elongated xylem strands separated by xylem rays from 1-to 5-cells in breadth whose cells contain starch and micro-crystals. The vessels (tracheae) occur in radially elongated to irregular-shaped groups or isolated and are accompanied by tracheids and wood fibers.

In longitudinal-radial sections which have been cleared with chloral hydrate solution the vessels exhibit ellipsoidal bordered pores, simple pits and reticulate markings.

Longitudinal-radial sections of Poke Root exhibit micro-crystals, like belladonna but acicular crystals of calcium oxalate also occur and, in thicker roots, vessels with diamond-shaped bordered pits are present.

Sections of stem bases exhibit a circle of bicollateral bundles, both inner and outer phloem strands of which show slightly lignified pericyclic fibers arranged singly and in small groups along their outer edges.

Powdered Belladonna Root: The diagnostic characteristics are the numerous single and 2-to 6-compound starch grains, the individual grains spheroidal, plano-to angular-convex and polygonal with a distinct excentric hilum and showing

polarization crosses in larger grains, usually up to 15 in diameter, occasionally up to 30 μ; numerous fragments of parenchyma, some of the cells filled with sphenoidal microcrystals up to 10 μ in length, the latter also occurring free; fragments of vessels some of which possess ellipsoidal bordered pits.

Constituents: Up to 0.8 per cent, occasionally 1 per cent of the alkaloids hyoscyamine and scopolamine, the principal one being hyoscyamine; the others, atropine, apoatropine, and belladonnine being formed in the process of extracting hyoscyamine; a fluorescent principle known as chrysatropic acid or B-methylaesculetin, starch, etc. Further details will be given under Belladonna Leaf.

Uses: The chief uses of belladonna root are pharmaceutically, for the manufacture of Fluidextract of Belladonna Root which with camphor enters into the Belladonna Liniment, for the manufacture of alkaloids, and for the Extract of Belladonna Root which enters into Belladonna Plaster. Medicinally, the fluidextract and extract have been employed in the treatment of Parkinsonism, and the extract is being used internally by some ophthalmologists as a mydriatic. Belladonna liniment is used externally as an anodyne in neuralgia.

BELLADONNA LEAF (BELLADONNAE FOLIUM) U. S. P.

Official synonyms: Deadly Nightshade Leaf, Belladonnae Folium, P. I.

The dried leaf and flowering or fruiting top of Atropa Belladonna L. It yields not less than 0.35 per cent of the alkaloids of Belladonna Leaf.

Each student is provided with a representative sample of the crude drug, a mount on cardboard of a branch of the plant bearing leaves, flowers and fruits, a small sample of powdered belladonna leaf and preserved or macerated material of the leaf and other parts of the drug from which he prepares sections for laboratory study. A permanent stained balsam mount of a cross section of the belladonna stem is also provided as well as preserved poke leaf, the most common adulterant. As in the case of Belladonna Root, in the lecture the diagnostic features of the unground drug and powdered drug, the constituents, uses and official preparations are taken up and all of the histology is given in the laboratory, the same general procedure being followed as in the case of the root. The official and other preparations, the alkaloids and alkaloidal salts of belladonna and herbarium materials of Atropa Belladonna, Atropa Belladonna var. acuminata and of plants whose leaves and leafy branches have occurred as adulterants of Belladonna Leaf are placed about the laboratory for examination by the student. During the week Belladonna and its products are being studied, important reference works including reprints are placed on a reserved library table for the student's perusal.

Unground Belladonna Leaf: The crude drug usually occurs as partly matted, crumpled or broken leaves together with some stems and a number of flowers and fruits. The leaves are thin and brittle. The lamina possesses a broadly ovate to ovate-lanceolate outline, an acute to acuminate apex, an entire margin, a decurrent base and slightly hairy surface. The petiole is slender. The flowers possess a green, 5-lobed calyx, a tubular-campanulate corolla with

5-small relobes which are brown to dusky yellow, 5 epipetalous stamens, and a superior, bi-locular ovary with numerous ovules bearing on its summit a slender style terminating with a capitate stigma. The fruit is a subglobular dark yellowish brown to dusky red or black berry containing numerous flattened, reniform seeds up to 2 mm. in width. The stems are more or less flattened and hollow. The odor is slight, somewhat tobacco-like, when moistened. The taste is somewhat bitter and acrid.

Histology - Leaf: Both epidermises, as observed in surface sections are composed of epidermal cells with waxy anticlinal walls, a striated cuticle and stomata, the latter being of the cruciferous type, the stomatal apparatus consisting of 3 to 4 neighboring cells surrounding the stoma, one of which is smaller than the rest. Nonglandular and glandular hairs occur as outgrowths from both epidermises. The nonglandular hairs are uniseriate and up to 6-celled. The glandular hairs are of two kinds; one possesses a uniseriate stalk and a 1-celled head, the other, a short club-shaped type, has a 1-celled stalk and a multicellular head.

The mesophyll consists of a single layer of palisade parenchyma beneath which occurs spongy parenchyma, the latter with scattered cells filled with microcrystals. The petiole, midrib and veins contain bicollateral bundles, the epidermis of the petiole showing branched nonglandular hairs.

Stem: The stem shows an epidermis with striated cuticle and fewer stomata and hairs, usually, than the leaf, a cortex of rounded parenchyma with scattered cells containing microcrystals and a distinct endodermis containing starch; a pericycle of 1 to 2 layers of parenchyma with a few pericyclic fibers either isolated or in small groups; a circle of bicollateral bundles, and a broad pith with scattered cells containing microcrystals.

Flower: The calyx exhibits an epidermis with numerous glandular hairs with uniseriate stalks and 1-to 3-celled glandular heads. The corolla possesses a papillose inner epidermis and an outer epidermis with numerous glandular hairs emanating from cells with wavy anticlinal walls; one type of glandular hair having a uniseriate stalk and a spherical, unicellular head, the other consisting of a uniseriate stalk and a row of globular secreting cells. The pollen grains are subspherical, from 40 μ to 50 μ in diameter, tricolpate, having 3 germinal furrows and rows of pits radiating from the poles to the equator.

Fruit: The epicarp exhibits polygonal epidermal cells with a striated cuticle and stomata near the apex and base. The mesocarp consists of large pulp cells, some containing rosette aggregates of calcium oxalate.

Powdered Belladonna Leaf: Light olive brown to olive green in color. The chief diagnostic elements are as follows: Fragments of wavy walled epidermis with striated cuticle, numerous dark gray to black crystal cells, numerous separated microcrystals, vessels with ellipsoidal bordered pores, the characteristic non-papillose nonglandular hairs. When the drug contains belladonna fruits, rosette aggregate crystals of calcium oxalate and fragments of the seed whose epidermis shows prominent ridges over the anticlinal wavy walls.

Constituents: The chief constituent is hyoscyamine although smaller amounts of atropine (except in young leaves), scopolamine and apoatropine are present, the volatile bases pyridine, N-methylpyrrolidine, and a diamine; a fluorescent substance called chrysotropic acid and scopoletin (B-methylaesculetin), etc.

Hyoscyamine (l-hyoscyamine), a crystalline alkaloid, is soluble in alcohol and is converted into the racemic or dl form (atropine) when treated with dilute solutions of caustic alkalis.

Atropine is a white crystalline alkaloid which also occurs in Atropa, Datura, Hyoscyamus, and some other genera of the Solanaceae and is prepared synthetically. It is composed of the isomers, dextro-and levo-hyoscyamine and is optically inactive. It is very soluble in alcohol but only slightly soluble in water. Its acid salts are very soluble in water.

Apoatropine is an anhydride of atropine and is stated to be devoid of mydriatic action.

Scopolamine (hyoscine) is an amorphous or syrupy levorotatory alkaloid that forms crystalline, water-soluble salts of which the bromides are the most stable.

Atropine Substitutes: A number of atropine substitutes have been synthesized which have one or two selective effects similar to atropine but with diminished undesirable actions. Two of these Homatropine Hydrobromide, U. S. P. and Homatropine Methylbromide, U. S. P. enjoy extensive use. Others include Novatrin, Eucatropine Hydrochloride, Syntropan, Pavatrine, etc.

Uses: The therapeutic uses of belladonna, its alkaloids and their preparations are based upon the nerve depressant properties of the alkaloids which block the responses of secretory glands and smooth muscles to cholinergic stimulation thus allowing andrenergic stimuli to act without restriction. They are used an anodynes, antiasthmatics, antispasmodics, mydriatics, to prevent the griping of irritant cathartics, to relieve pain, to relax overcontracted smooth muscle, decrease secretion, for noght sweats of phthisis, etc.

The alkaloid atropine and its sulfate are used to diminish the secretions of mucous, saliva and sweat, to lessen pain by depressing sensory nerve endings, to relax over contracted smooth muscle in asthma, spastic constipation, etc., in spasmodic nervous conditions as in pertussis, etc., to check excessive vagus activity, as in partial heart block, in spasmodic dysmenorrhea, biliary and renal colic, and in the treatment of poisoning by various depressants like opium, chloral, etc. They are also employed in ophthalmology as mydriatics and cycloplegics, and in inflammatory conditions of the eye, as iritis and keratitis. They dilate the pupil, paralyze accommodation, increase intraocular tension and lessen pain.

Homatropine Hydrobromide is prepared from tropine and mandelic acid. It is used as a mydriatic and cycloplegic and is preferred to atropine for ophthalmoscopic examinations, owing to the shorter duration of the mydriasis it induces.

Homatropine Methylbromide is used as an antispasmodic and inhibitor of secretions in irritable colon, spastic constipation, and in peptic ulcer to counteract pylorospasm, and in other gastrointestinal disorders. Usual dose, 2.5 mg.

Preparations: In U. S. P. - Belladonna Tincture, 0.6 cc (10 minims), Atropine, 0.4 mg., Atropine Sulfate, 0.5 mg., Atropine sulfate tablets, Scopolamine Hydrobromide, 0.6 mg., Scopolamine Hydrobromide Tablets. In N. F. - Belladonna Leaf Fluidextract, 0.06 cc., Belladonna Ointment.

Adulterants: Leaves of Phytolacca decandra which exhibit raphides of calcium oxalate in addition to microcrystals; excessive belladonna stems; leaves of Ailanthus glandulosa which are triangular ovate with sharply acute apex and show I-celled, conical hairs, rosette aggregate crystals and ranunculaceous stomata; Leaves and tops of Scopolia carniolica and of Solanum nigrum, etc.

Belladonna from the Phytochemical Viewpoint

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University of Arizona

The presentation of didactic subject matter on the drug, belladonna in actual teaching experience is preceded by a brief period of general course introduction and a longer period devoted to earlier scheduled groups of drugs including enzymes, carbohydrates, glycosides, proteins, fats and oils, and essential oils. The material covered and the time required to arrive at the point in the course when the alkaloid-bearing drugs are considered will depend upon the classification employed by the instructor.

In presenting the drugs of belladonna as an isolated unit, it is necessary to include certain points of information from the general introduction to the course and from the introduction to the alkaloid group. Consequently, this presentation is not absolutely identical with that which would be given in the classroom by this instructor, but is very nearly so, and is as follows:

Belladonna Leaf and Belladonna Root
Classification: Alkaloid Constituent Drugs.

Introduction - Belladonna is a drug plant of long standing importance in medicine and pharmacy. Dioscorides, who lived about 78 B. C., wrote of its poisonous effect on Roman soldiers who, under Anthony were retreating from the Parthians. As their provisions were low, they resorted to eating strange plants along the way including one we know now as belladonna. Dioscorides attributed to this plant the loss of senses and the death of some of the soldiers.

The plant was described under the name Solatrum Majus in 1558 and later as Herba Bella Donna by the Venetians from the circumstance of the Italian ladies using an aqueous preparation of the plant as a cosmetic for the eyes. In the jargon of the present day college student, this name and application have undergone conversion in the expression, "herbs for the orbs."

In 1753, the plant appeared in Linne's Species Plantarum under the name, Atropa belladonna. The genus name was taken from the name of the third of the three fates in Greek mythology who spun, measured and cut the thread of life for all mortals. This is indicative of an early understanding of the deadly nature exhibited by this plant toward animal life. Belladonna is a member of the Solanaceae family in which occur such common plants as petunia, tobacco, potato and tomato. Other important drug plants of this family are various species of Hyoscyamus (the henbanes), Datura, (stramonium or jimson weed) and Capsicum (red pepper).

Belladonna and its preparations have numerous uses. They are employed as mydriatics in ophthalmology, respiratory stimulants, antispasmodics in various colics, depressants of glandular secretions, agents for the relief of paralysis agitans and parkinsonism, local anodynes and antagonists for mushroom and pilocarpine poisoning effects. Further evidence of the importance of

belladonna in medicine may be indicated by the fact that it has appeared in one form or another in all of the official drug compendia of the world. The United States Pharmacopeia has listed the leaves since the first printing in 1820. The roots occurred in the U. S. P. from 1860 to 1947 and since that time have been listed in the National Formulary.

Products - Official recognition in the United States of the products and preparations of belladonna at the present time may be summarized as follows:

U. S. P. XIV --

1. Belladonna Leaf (Deadly Nightshade Leaf) Dried leaves containing not less than 0.35% alkaloids. Dose: (Non-official, 1 gr.)

2. Belladonna Extract (Belladonna Leaves Extract) From 1.15% to 1.35% alkaloids. Prepared by maceration, percolation and evaporation of the dried, powdered leaf. Available in officially recognized pilular and powdered forms. Dose: 15 mg. or approximately 1/4 gr.

3. Belladonna Tincture (Belladonna Leaf Tinct.) From 0.027% to 0.033% alkaloids. Prepared by process of percolation as modified for assayed tinctures. Dose: 0.6 cc or approximately 10 Minims.

4. Atropine - consists of the racemized levohyoscyamine obtained from belladonna and other solanaceous species or produced synthetically. Extremely poisonous! Dose: 0.4 mg. or approximately 1/150 gr.

5. Atropine Sulfate - consists of the sulfate salt of atropine, prepared by conversion of the base, in organic solvent solution, with the minimum amount of diluted sulfuric acid required. Extremely poisonous! Dose: 0.5 mg. or approximately 1/120 gr.

6. Atropine Sulfate Tablets - a convenient dosage form and convenient form for dispensing work. Three per cent plus or minus allowance is made on labeled amount of atropine sulfate for tablets of 20 mg. or larger. Ten per cent allowance plus or minus is made for tablets under 20 mg.

N. F. IX --

1. Belladonna Leaf Fluidextract. From 0.27% to 0.33% alkaloids. Prepared by Process A (percolation with one alcoholic menstrum) as modified for assayed fluidextracts. May also be prepared by Process E (pressure percolation). Dose: 0.06 cc. or approximately 1 Minim.

2. Belladonna Ointment (Belladonna Leaf Extract Ointment). From 0.11% to 0.14% alkaloids. Prepared by incorporation of pilular extract in yellow ointment. Used externally.

3. Belladonna Root (Deadly Nightshade Root). The dried root containing not less than 0.45% alkaloids. Dose: (Non-official, 3/4 gr.)

4. Belladonna Root Fluidextract. From 0.405% to 0.495% alkaloids. Prepared by Process A as modified for assayed fluidextracts. Dose: 0.05 cc. or approximately 3/4 Minim.

5. Belladonna Liniment (Belladonna Root Liniment). Consists of a solution of 5% camphor in Belladonna Root Fluidextract. Used externally.

6. Belladonna Plaster (Belladonna Root Plaster). From 0.25% to 0.30% of a belladonna root extract incorporated in an adhesive plaster mass. Used externally.

Homeopathic Pharmacopeia -

1. Belladonna. Consists of the whole plant collected when it begins to flower. It is employed in the form of tinctures and dilutions of 1:10, 1:100 and 1:1000 strength.

2. Atropinium. Isolated principle employed in triturations, tinctures, dilutions and medications in 1:10 to 1:1000 strength. Maximum dose: 1/64 gr.

3. Atropinium Sulphuricum. Sulphuric treated isolated principle. Same preparations as of Atropinium. Maximum dose: 1/50 gr.

Commercial Data - The chief sources of the crude leaf and root products of belladonna employed in the United States are plants cultivated in this country. However, the drug occurs in both import and export reports at the present time with current price listings varying from 30 to 40 cents per pound. The chief overseas sources are the central European countries. Imports as large as 65 tons were recorded annually prior to World War II. The shortages which developed as a result of shipping restrictions stimulated cultivation and research in this country with the result that sufficient quantities may now be produced to provide for export business.

The current trend toward increased employment of pure, isolated active ingredients or synthesized substitutes and derivatives in place of the crude drugs and galenicals has decreased the demand for the latter on the pharmacy shelf. Whereas the prescribing of the tinctures and fluidextracts by medical practitioners is diminishing, the requests for tablets, solutions and manufactured "specialty" combinations are increasing.

Monograph Interpretation - In spite of the foregoing facts on the decreasing employment of the crude drug in retail pharmacy, the pharmacist will be responsible for his potential capacity as a dealer in the crude drugs and should be conversant with the information of the monographs. Consequently, the student must be trained to interpret the official terminology of the macroscopic and microscopic descriptions of the drugs, of the rubric, the assay and any other information given. He should be able to identify the drugs and detect their adulteration. A coordinated laboratory assignment will permit the study required for gaining experience in interpreting the pharmacognostic descriptions. Since the alkaloidal assay procedures will be discussed in detail in the drug assay course (or the quantitative pharmaceutical chemistry course) and actual experience provided for in its laboratory section, it will be sufficient to outline only briefly the principles underlying the steps of the official assay. This can be accomplished more efficiently if incorporated with a discussion of the medicinally active proximate constituents of the belladonna drugs.

Solanaceous Alkaloids - This group of alkaloids is represented chiefly by levo-hyoscyamine, its racemic isomer, dl-hyoscyamine, known as atropine, and by scopolamine which is also known as hyoscine. Minor alkaloids of the group include apoatropine, nor-atropine, belladonnine and meteloidine. The various parts of the belladonna plant may contain as much as 0.8% of hyoscyamine and 0.5% scopolamine on a dry weight basis. The usual total alkaloidal content of commercial supplies of belladonna leaf varies from 0.3% up to 0.5% but special collections may be found which approach 1%. Average figures for the dried root are slightly higher. The student should keep in mind the official requirements of 0.35% and 0.45% total alkaloids for the leaf and root respectively.

Properties of the Alkaloids - The hyoscyamine and scopolamine alkaloids are closely related chemically, both being esters of tropic acid, but with tropine base and scopine base respectively. Scopine differs from tropine in having an oxygen bridge, in place of two atoms of hydrogen, between the 6 and 7 carbon atoms. The student should review at this time these chemical structures as presented in the course in pharmaceutical chemistry. Furthermore, in preparation for the study of relationship between chemical structure and physiological action, the student may find excellent graphic portrayals on the subject in any modern text in organic pharmaceutical chemistry. Particular attention should be given to the presence of the nitrogen atom in the alkaloidal structures because it is of outstanding importance to the properties of these compounds.

Atropine, official in the U. S. P. since 1863, is generally believed to be formed in the process of extraction from the crude drug as the optically inactive and physiologically less active isomer of levo-hyoscyamine. It is the classic example of the solanaceous alkaloids and its properties typify the others found in belladonna. It is usually obtained commercially from the plant sources but may be produced synthetically by the condensation of the aromatic acid, tropic acid, with the nitrogenous base, tropine, also known as tropinol. The latter is prepared by a modification of the Robinson synthesis utilizing comparatively simple compounds--succindialdehyde, methylamine and acetonedicarboxylic acid. Tropic acid may be synthesized from acetophenone by the Ladenburg method.

The isolation of atropine and the other alkaloids is based on the solubility characteristics common to alkaloids in general--the possession of appreciable solubility in the water-immiscible organic solvents but insolubility in water itself. Exactly the opposite solubility characteristics are produced by treatment with a dilute acid. In this treatment, the acid radicle and the replaceable hydrogen are added to the molecule at the nitrogen atom. The appropriate manipulation of the immiscible solvents, following the changes of reaction in the mixture being processed, permits the elimination of undesirable extractive material from the plant tissues and the ultimate crystallization of the alkaloids. The powdered drug is first macerated with an alkaline solution. Ammonia is commonly employed. This assures conversion of the alkaloids to the basic state in which they may be separated from the tissues by use of ether, chloroform or other organic solvents. The resulting alkaline solution is extracted by the use of an aqueous dilute acid which draws off the alkaloids as a water soluble acid salt mixture and rejects most of the extractive wastes. By rendering the acid solution of the alkaloids basic again with ammonia and extracting with chloroform, the alkaloids may be obtained in relatively pure, crystalline form as a residue of evaporation of the chloroform. The official solanaceous alkaloid assay process follows this same type of procedure and then provides for a determination of percentage yield by means of a residual titration employing standard acid and base solutions. The student should become familiar with these procedures in the laboratory exercises of quantitative pharmaceutical analysis.

Pure atropine occurs as a bitter tasting, white crystalline powder, soluble at ordinary temperatures in 460 cc of water, 27 cc of glycerin, 25 cc of ether, 2 cc of alcohol and 1 cc of chloroform. Through the activity of the nitrogen atom in its structure, atropine, as well as other alkaloids, reacts with certain precipitant reagents to give insoluble, sometimes colored products useful in detecting and determining identity and purity. Mercuric potassium iodide solution (Mayer's reagent) produces a cloudy precipitate with atropine in very dilute solutions. Mercuric chloride solution produces a yellow to red precipitate, and tannic acid a white precipitate. Iodo-potassium iodide solution (Wagner's reagent) produces a reddish brown precipitate while that of picric acid solution (Hager's reagent) is yellow. A potassium bismuth iodide solution (Dragendorff's) produces a reddish to bright yellow separation. Certain oxidizing reagents give indications of the identity of atropine. For example, its crystals warmed with sulfuric acid and a small crystal of potassium dichromate result in a benzaldehyde aroma. When evaporated to dryness with concentrated nitric acid, its yellow residue will take on a violet color if moistened with alcoholic sodium hydroxide (Vitali's Test). This test is characteristic for hyoscyamine and scopolamine as well as atropine, but the color change is obscured if other alkaloids are present. A rapid distinction between atropine and hyoscyamine can be made by adding gold chloride test solution to a diluted hydrochloric acid solution of the crystals. The resulting precipitate with atropine is lusterless but with hyoscyamine it is lustrous.

Natural Formation of the Alkaloids - The biogenesis of atropine and the other alkaloids in belladonna is a mystery which is only very slowly yielding to investigation. The majority of alkaloid structures may be regarded as representing various modifications of the pyridine ring, but although it can be theorized that

the deammoniation of diamino derivatives of naturally occurring dicarboxylic acids could result in such a structure in plant cells, the steps leading to this synthesis have not been established with certainty in plant physiology.

Experiments in which non-alkaloidal scions have been grafted onto alkaloid producing root stocks and alkaloidal scions on non-alkaloid producing root stocks have indicated that alkaloids are predominantly synthesized in the roots of plants. It is undoubtedly true, however that products from the leaves of plants are necessary for the syntheses which are completed in the roots. The problem is complicated somewhat by evidence that some alkaloids are not produced in roots but in the leaves or stems. The solanaceous alkaloids, apparently root products, appear quite rapidly in relatively high concentrations in the zones of greatest metabolic activity in the plant. Thus these alkaloids appear in the young leaves, presumably by the process of translocation. By this same process, the alkaloid content of the leaves of belladonna may be increased, following harvesting, at the expense of the quantity in the roots and stems, by permitting the whole plant to remain intact while drying. Higher yields of belladonna alkaloids may be obtained by employing nitrogen and potassium soil fertilizers early in the development of the plants and by harvesting at the time of flowering.

Relationship of Alkaloidal Properties to Dispensing Problems -

Among the properties of atropine and other belladonna alkaloids which give rise to compounding problems are: (a) insolubility of basic alkaloids in water, (b) insolubility of acid salts in oils and the organic solvents, (c) precipitation and discoloration with many preparations containing halogens and certain organic acids, (d) hydrolysis of alkaloids in neutral aqueous solutions, especially when subjected to heat, and (e) the acidity of solutions of the alkaloidal salts. Because of the potency of the alkaloids physiologically, their precipitation in a prescription constitutes a danger because of the possibility of the patient' s withdrawing an excessive dose. Consequently the pharmacist must be constantly alert to avoid such separation as well as to avoid outright overdosage in the prescription.

A typical incompatibility encountered with atropine sulfate in practice may be illustrated by the following prescription:

Atropine Sulfate	gr 1/8
Phenobarbital Sodium,	gr viii
Cherry Syrup	
Dist. Water, aa, qs ad	fl. oz. iv
Ft. Sol.	

Here, the acid characteristic of atropine sulfate in aqueous media releases phenobarbital from its sodium combination. The phenobarbital is insoluble in the water and precipitates out. The difficulty may be remedied by employment of an alcoholic vehicle which will maintain the phenobarbital in solution.

Official Synthetic Substitutes for Atropine Sulfate - Searches for substitutes for atropine sulfate which would exhibit shorter duration of mydriatic effects

have resulted in synthetic compounds closely related to the natural drug chemically. Two examples are: (a) Homatropine Hydrobromide, the tropyl ester of mandelic acid--its hydrobromic acid salt, and (b) Eucatropine Hydrochloride. the tetramethyl, hydroxypiperidine ester of mandelic acid--its hydrochloric acid salt.

Non-Official Prescription Specialties -- A current trend of great popularity among the pharmaceutical manufacturers is the patenting and marketing of typical prescription combinations of the more valuable drugs and their constituents. Examples of names of a few antispasmodic prescription combinations containing atropine or its substitutes or derivatives along with other therapeutic agents and the name of the manufacturer are shown below:

Amethone Ampuls (Abbott)
Artane Tablets (Lederle)
Bellabulgara Tablets (Lederle)
Belladenal Tablets (Sandoz)
Bellefoline Ampuls (Sandoz)
Bellergal Tablets (Sandoz)
Companol Tablets (Winthrop-Stearns)
Delkadon Tablets (Sharp and Dohme)
Eumydrin Tablets (Winthrop-Stearns)
Homabital Tablets (Schieffelin)
Novatrine Ampuls, Tablets (Campbell Products)
Pavatrine Tablets (Searle)
Priscoline Tablets (Ciba)
Rabellon Tablets (Sharp and Dohme)
Syntronal Tablets (Hoffman LaRoche)
Syntropan Tablets (Hoffman LaRoche)
Trasentine Tablets (Ciba)
Vinobel Tablets (Merrell)
Wyanoid Suppositories (Wyeth)

Reference Material - The student will find additional information of great value in pharmacy on the subject of belladonna products in the vast number of references available, only a few of which can be enumerated here: United States Pharmacopeia, National Formulary, Homeopathic Pharmacopeia, United States Dispensatory, Journals of the American Pharmaceutical Association and the American Chemical Society, current editions of pharmacognosy textbooks by Youngken, Pratt and Youngken, Jr. and Gathercoal and Wirth, current editions of textbooks in organic pharmaceutical chemistry by Wilson and Gisvold and Jenkins and Hartung, Modern Drug Encyclopedia, Merck Index, Plant Alkaloids (Henry), Organic Chemistry (Karrer) and Plant Biochemistry (Bonner). Credit for the contents of this paper for the most part must be given to the forementioned sources.

The Justification of Teaching Belladonna from the Physiological Viewpoint

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I have been asked to discuss the teaching of belladonna from the physiological viewpoint and have accordingly prepared an outline of a lecture (Table I) based on the physiological approach.

With your kind indulgence I shall preface this specific outline on belladonna with a more general discussion of the various approaches which have been used or might be used in instruction in pharmacognosy, in order to attempt to clarify and justify the physiological approach in teaching the course, whether the specific subject be belladonna or any other drug of biological origin. I shall necessarily have to indicate also the proper chronological position of pharmacognosy in the curriculum as dictated by the logical prerequisites in the hope that we may integrate the subject into the course of pharmaceutical training, not arbitrarily, but with painstaking and intelligent regard for what precedes and for what follows.

Pharmacognosy has for many years been the subject of considerable discussion as to content and organization. In this discussion such questions as the following have arisen: What plant and animal drugs should be included in the pharmacognosy course? What information should be considered with respect to each drug? What classification should be used to organize the subject matter? What are the prerequisites?

The first question may be answered in part by an inspection of the official compendia, the N. N. R., the Modern Drug Encyclopedia (1), and prescription surveys. The other questions are interrelated and will be considered together.

Before attempting to appraise the value of any of the classification methods for presenting specific subject matter in the general course of pharmacognosy, it may be well to review the stated objectives of the course and some of the related problems. The Pharmaceutical Curriculum by Blauch and Webster (2) includes the following as objectives of instruction in pharmacognosy:

1. Understanding of the constituents of products of biological origin having current medicinal and pharmaceutical importance and of their preparations as a basis for determining whether any two or more drugs or preparations are compatible.

2. Knowledge and understanding of the pharmaceutical and therapeutic applications of natural products in pharmaceutical preparations and medicaments as a foundation for specific instruction given in the courses in pharmacy and pharmacology.

3. Knowledge of the methods by which products of natural origin are evaluated.

4. Knowledge of the production and commerce of products of natural origin.

5. Understanding of the technical aspects of natural products which are involved in the legal regulation of the products.

6. Knowledge of such substances as fungicides, insecticides, herbicides and rodenticides used in the control of public health menaces.

It is apparent from a review of these objectives that pharmacognosy is concerned primarily with a knowledge of the physical and chemical properties of constituents and extractives of crude drugs. This knowledge is a foundation for instruction in courses in dispensing pharmacy and pharmacology. Such knowledge is essential to the pharmacist in the compounding of prescriptions and in his advisory capacity to the physician. Although preparation of the student for the state board of pharmacy examinations is not generally included in published lists of objectives, there are definite indications that this factor does influence some teachers in their presentation of subject matter. This problem has been discussed in a recent paper by Hiner. (3)

We are ready to consider the question: " What classification should be used to organize specific subject matter in the pharmacognosy course?" The principal forms of organization (2) are as follows: taxonomical, (4, 5) morphological, (5) biochemical, (6-14) physiological, (15-16) and therapeutic. The answer to this question depends upon the year in which pharmacognosy appears in the curriculum and upon the training and background of the teacher. The writer in a recent survey of the curricula of seventy colleges of pharmacy noted the basic course was offered by most of the colleges in the second or third year. It was further noted that a course of six or eight semester hours, consisting respectively of four or six semester hours of didactic instruction and two semester hours of laboratory instruction was offered in the majority of the schools.

The Pharmaceutical Curriculum by Blauch and Webster (2) contains a suggested four-year curriculum based on the semester plan. The plan includes a pharmacognosy course of six semester hours, whereas in the section on biological sciences it is suggested that the course should carry eight semester hours of credit (two lectures and two three-hour laboratory periods each week for two semesters).

Those schools offering pharmacognosy in the second year would be able to use the morphological or taxonomical method of presenting but would not be able to use the physiological, biochemical or therapeutic approach. Organic chemistry, botany and zoology are prerequisites to an effective presentation of subject matter by the physiological or biochemical approach. Parks (17) advocates biochemistry as a prerequisite to pharmacognosy when presented by the so-called modern approach involving emphasis on the biochemical aspects and on the chemistry of natural products. This arrangement is hardly possible, since biochemistry should be offered no earlier than the junior year of the four-year program. It would seem logical that physiology and pharmacology should be prerequisites to the therapeutic approach, and these courses are offered in

the junior and senior years, respectively.

Those schools offering pharmacognosy in the third year would be able to use the morphological, taxonomical, physiological, or biochemical classification but would not be able to use the therapeutic system for reasons previously indicated.

Pharmacognosy obviously could not be offered in the freshman year and, since it is a foundation course for study in dispensing pharmacy and pharmacology, it should not be included in the senior year.

It would appear then that pharmacognosy might be placed in the sophomore or in the junior year. As was suggested earlier, the offering of pharmacognosy in the second year would require the use of the taxonomical or morphological approach. That these two systems are inadequate is indicated in a statement from The Pharmaceutical Curriculum. (2) "However, in spite of their advantages, the taxonomical and morphological schemes cannot adequately serve pharmacognosy from a practical point of view because they are not sufficiently related to the qualities which make the products useful."

Blauch and Webster in The Pharmaceutical Curriculum (2) point out the values and advantages of the biochemical and physiological approaches and have included suggested outlines for each. This report also includes two four-year curricula organized respectively on the semester and quarter plans. Pharmacognosy is placed in the sophomore year of the semester plan and in the junior year of the quarter plan. It is obvious from the foregoing that pharmacognosy cannot be taught in the sophomore year but rather must be included in the junior year. (10) On the basis of the above facts and reasoning, it is suggested that the course be placed in the junior year of the four-year curriculum and that the subject matter be organized on a biochemical or physiological pattern.

Finally the question, "Which of the two methods of classification, physiological or biochemical, is likely to provide the more effective method of presentation?" It will be remembered that the prime objective concerns a knowledge of the drugs, extractives, and constituents of biological origin, including their physiological activity. The physiological pattern as outlined by Youngken and Neva (15) and the biochemical as reported by others (6-14) emphasize this objective. The authors of the physiological pattern recommend a course of eight semester hours (three lectures and one two-hour laboratory period each week for two semesters).

I should like now to return to the specific subject of this paper and present my outline of a lecture on belladonna, using the physiological approach. It is assumed that the alkaloids in general have been discussed before the time this lecture is given. I refer you once again to Table I.

In conclusion I must state that we cannot allow pharmacognosy to wither on the vine. It was reported (18) in 1951 that the supply of trained pharmacognosists was inadequate and also that the number of students preparing to become

professional pharmacognosists was not enough to provide for the needs of colleges, let alone other needs, in the foreseeable future. It is probable that graduate students in pharmacognosy will come largely from the students enrolled in the undergraduate curriculum. It is very firm belief that the attraction of capable students into our field of endeavor will be favorably influenced by the following factors: 1) The presentation of subject matter of undergraduate pharmacognosy on the biochemical or physiological systems which draw heavily upon a background of plant and animal physiology and chemistry. 2) The conduction of basic research relative to biosynthesis, genetics, ecology, and the nature of constituents of potential plant and animal drugs.

TABLE I

An Outline of a Lecture on Belladonna from the Physiological Viewpoint

Subject	Content
English and Latin Title	Derivation of Latin title
Historical Background	Source of synonyms and significance of P. I. Brief history of plant including early uses and introduction into medical practice and official compendia
Classification of Active Constituents	Basic chemical nucleus - Tropane alkaloids Site of physiological activity - Neurotropic Brief review of structure and function of autonomic and central nervous system
The Official Definition and Rubric	Parts of plants used and their condition (dried) Botanical origin including derivation Family - important characteristics and other plants of economic importance Official rubric - per cent of alkaloids
Production and Commerce	Habitat and commercial origin
Description of Plant and Crude Drug	Collection of drug parts and preparation for market Preservation and storage External appearance of plant and whole drug
Active Constituents	Name and structure of active principles of Belladonna and related Solanaceae medicinal plants Physical and chemical properties of alkaloids including incompatibilities Chemical and physiological relationship of Belladonna alkaloids, other Solanaceae alkaloids and synthetic products Biogenesis of the alkaloids of Solanaceae plants Official assay Tropane alkaloids (other than Solanaceae)
Official and Proprietary Products	Official and proprietary products containing extract, tincture, alkaloid, etc. of Belladonna Use and dose of official preparations and alkaloids of Belladonna

SUMMARY

1. The objectives and methods of presenting subject matter in the undergraduate pharmacognosy course are discussed.

2. It is recommended that pharmacognosy be placed in the junior year of the four-year curriculum and that the subject matter be organized on a physiological or biochemical pattern. Prerequisites are discussed.

3. An outline of a lecture on belladonna from the physiological viewpoint is presented.

4. The importance of attracting capable students into the field of pharmacognosy is stressed.

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Section E - LABORATORY INSTRUCTION

in

PHARMACOGNOSY

The Scope of Student Achievement in the Pharmacognosy Laboratory

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Although it has been reported that approximately 800 plant and animal drugs, spices, etc. are encountered in American commerce, it is also well known that very few of these crude drugs are to be found on the drug store shelves in modern times. The absence of crude drugs in the shops today, in contrast to their common occurrence a generation ago, erroneously leads the student of pharmacy to the view that plant drugs are no longer used in medicine and are becoming obsolete. Why, then, devote time to a laboratory study of products which he as a retail pharmacist will rarely encounter in his shop? The answer, of course, should be quite obvious. While it is true that the average pharmacist no longer sells the crude drug, it is also true that he dispenses the refined or manufactured items from perhaps an even greater variety of crude drugs than ever found sale over the counter by his predecessors. Hence his contact with the drug product occurs only through the name of the drug in the list of ingredients on the label of the manufactured item.

Laboratory work in pharmacognosy, therefore, should be planned to achieve the following objectives: 1) to develop certain skills in applying the various tests for identity and purity of drugs, and familiarity with the basic scientific principles underlying these tests; 2) to discover certain diagnostic microscopic characteristics of several drugs; and 3) finally to provide an opportunity for the student to become personally acquainted with the official drugs and a few others that are used in modern medicine.

If Wasicky's definition of pharmacognosy in the modern sense be accepted as that branch of science which deals with the physical and chemical properties of plant and animal drugs, it must be assumed that one phase of the laboratory work in the subject should point toward the achievement of a knowledge of these properties as an implementation of the didactic presentation of the subject. The biochemical approach to the subject, therefore, is to be recommended, not only from the standpoint of the student's background or preparation, but also because official drugs in the respective biochemical categories may be considered together in the laboratory. For example, the various drugs containing coloring principles, such as red saunders, cudbear, cochineal, alkanet, etc., can be considered together and the best solvent for extracting the coloring principles from each, as well as color changes of each in acid, neutral and alkaline media can be compared. Likewise the tannin-containing drugs may be considered as a class, and by appropriate tests the specific type of tannin may be determined as well as the effects of such tannins on various reagents, such as alkaloids, protein material, salts of heavy metals, etc. Other biochemical groups include the large body of carbohydrates: sugars, starches, gums, mucilages, phycocolloids, pectin, glycosides, alkaloids, saponins, resins, volatile oils, fats and fixed oils, waxes. Naturally there will be certain drugs which cannot be classified in the above categories and must be dealt with individually.

Each of the above groups affords an opportunity to learn certain principles in connection with the various tests for identity and purity applied to the individual drugs. In the carbohydrate drugs, for example, a few simple tests for the various types of sugars, may be carried out in the laboratory, using official sugars to distinguish between monosaccharides and disaccharides, between reducing and non-reducing sugars, the effects of hydrolysis of disaccharides and the more complex derived carbohydrates, such as starch, gums and mucilages, phycocolloids. The presence of certain cations and anions among the products of hydrolysis of the latter substances can be related to the chemical structure of these. Similar tests on certain glycoside-containing drugs will establish some definite concepts of the chemical make-up of the particular glycoside in a drug. The amygdalin in wild cherry bark, bitter almonds, cherry laurel, etc. may be readily hydrolyzed in the laboratory, and the aglucon benzaldehyde readily detected by its odor. The presence of a reducing sugar after hydrolysis can then be readily demonstrated. Similar tests can be performed with the mustard seeds to demonstrate the presence of glycosides whose aglucones are odoriferous. In the case of the drugs containing anthraquinone glycosides, the aglucan portion of the molecule is identified by a color complex in alkaline solution.

The saponin-containing drugs, quillaja, senega, sarsaparilla, afford examples of the behaviors of saponins when shaken with water.

Laboratory study of resin and resin-containing drugs should include tests or experiments that will determine both physical and chemical properties of the various classes, such as solubilities in various organic solvents and in alkaline solution. The gum-resins may be identified by their ability to form emulsions when triturated with water. The special property of milk of gamboge when made alkaline with ammonia water may then be demonstrated. The so-called balsamic resins may be identified by micro-sublimation of benzoic and cinnamic acids and identification of these by their crystalline forms or melting points. Also, the distinction between Siam and Sumatra benzoin may be demonstrated by chemical means by oxidizing the cinnamic acid in the latter to benzaldehyde, which may be recognized by its odor. The precipitation of the resin by pouring the alcoholic solution into water illustrates the basis for the preparation of the galenical resins from such drugs as jalap and ipomoea, podophyllum, etc. The special interesting usefulness of guaiac resin as a reagent for oxidase enzymes may be demonstrated on blood, acacia, and mesquite gum, myrrh, etc.

What might be done in the laboratory with fixed oils, fats, waxes? Solubilities of the oils and fats in organic solvents will demonstrate the distinctive properties of castor oil which can be correlated with its unique chemical structure. Its solubility in alcohol constitutes the basis for the detection of castor oil as an adulterant in chaulmoogra oil. The Halphen test for cottonseed oil in olive oil and the furfural test for sesame oil in olive oil demonstrate the presence of certain impurities in these two oils which are not present in olive oil.

The laboratory study of alkaloids and alkaloidal drugs will provide an op-

portunity for methods of extracting alkaloids from the drugs, as well as determining general chemical properties and demonstrating the use of alkaloidal precipitants. Differences between alkaloids may be demonstrated, as with strychnine and brucine and with quinine and cinchonine.

The various physical and chemical tests applied to drugs should include not only those listed in the official compendia but other tests which other source books and experience have demonstrated to be of value in identification of a drug or the detection of adulterations. In many cases, such tests for identity and purity are made more meaningful to the student if parallel tests are carried out on the adulterated or impure drug in question so that he can discover for himself the effectiveness of such tests. Thus he can interpret the Halphen test for cottonseed oil in olive oil, the test for sulfites in chondrus, for stearic acid in spermaceti, for vegetable shortening in lard, etc., etc.

Acquiring a working knowledge of the various tests applied to drugs and drug products is only a part of the objectives of laboratory instruction in pharmacognosy. A number of drugs, such as lycopodium, siliceous earth, kamala, lupulin, starches, have definite microscopic features which should be emphasized as a part of the laboratory study of such drugs. Moreover, it is desirable to point out certain diagnostic microscopic characteristics of certain closely related powdered drugs as a means of differentiating between, and sometimes detecting adulterants in each. A case in point is that of powdered cascara and powdered frangula, the first of which contains stone cells and the latter does not. Also certain powdered leaf drugs may be identified by microcrystals or trichomes, such as hyoscyamus, stramonium, digitalis, and eriodictyon. However, a heavy diet of microscopic characterization of powdered drugs is not to be recommended because of not only inadequate background of students at the undergraduate level, but also the almost complete lack of practical value in retail pharmacy of such emphasis. Microscopic studies are best offered at the graduate level with adequate background in plant anatomy and cytology. In other words, microscopic study should not be attempted as routine procedure on every crude drug studied in the laboratory, but should be restricted to those drugs that have such relatively simple diagnostic characteristics which the undergraduate student will be able to recognize and interpret. Thus in the laboratory study of colchicum, a sample of the powdered corm might be examined for the compound starch grains, and powdered ginger likewise for its starch grains, including the Japanese ginger with its compound starch grains which aid in the detection of the latter as an adulterant in official ginger.

A special case should be made of cannabis, in my opinion, because of the nature of the special narcotic and sociological problems which it presents. Although the drug is seldom encountered officially or legally as a therapeutic agent, the illegitimate traffic in it is so considerable, especially in the southwestern states and in the large urban communities, that the pharmacist should be prepared to make a contribution to the effective dealing with the marihuana problem. To this end, a thorough study of all its forms--whole plant, dried inflorescence, dried leaves, cigarettes, powder, or extracts--should be accorded this drug by chemical, physical, microscopic, and perhaps biological

means. The student is generally deeply interested in this subject because of wide notoriety given it in the press; and specimens of the drug as it appears in the illegal market, cigarettes, herbarium sheets of both the male and female plants, or photographs of those if the plant is not available for herbarium sheets.. all intensify the interest of the student and equip him to identify the drug whenever he may encounter it. He is thus able to cooperate with law enforcement officers in the control of the drug. This laboratory has had numerous plants referred to it as marihuana suspects, ranging from bur clover to Virginia creeper; identification of the drug could be made by every pharmacist, even in the smallest communities, by proper training.

Although the various physical, chemical, and microscopic tests are important features of the laboratory study of drugs, there is yet one other aspect that equals if, indeed, it does not excell these in importance. This aspect of the study concerns direct, personal contact with the crude drug, including those for which no specific tests are listed, and establishing an acquaintance with it by organoleptic methods. It will be quite impossible, of course, to establish a lasting personal acquaintance with the great number of drugs on the market; the effort should therefore be restricted to few more than the official ones.

Personal contact by the student with the crude drug and drug plant serves a purpose similar to that which a museum serves to the student of history or of art or of archaeology. The museum contains the objects which constitute the basis of inquiry. Again, the personal contact with the drug may be compared with the personal contact with or introduction of a student to the author of the textbook he uses. And although the contents of the book are in no wise altered because of this acquaintance with the author, nevertheless the book takes on added importance and implications because of it. In like manner, acquaintance with the crude drug will add considerable interest to the study of the products derived from it. The student of pharmacognosy may acquire considerable knowledge of the biochemical principles in drugs and of their usefulness from his reading and attendance upon lectures, but his knowledge will be incomplete and therefore not entirely satisfying until he has made the acquaintance of the plant or animal drug which yields such fascinating and valuable principles. Henceforth, the name on the label calls to mind something tangible and therefore more satisfying. The personal contact with the crude drug in the laboratory is thus calculated to develop greated interest in the medicinal products of plant and animal origin.

However, mere personal contact with the drug will not in itself engender any considerable enthusiasm. After all, the first introduction of the student to crude drugs such as Irish moss, belladonna root, or asafetida is not altogether an inspiring and thrilling experience! In many cases, it will require the use of all available related material to screw up the student's interest in drug products which in themselves are so often utterly lacking in any form of appeal.

In the first place, the instructor's interest in and enthusiasm for the subject matter is one of the prime requisites for arousing the interest of his

students. If he is lacking in these assets or in a wide knowledge of the whole field of crude drugs, he can scarcely hope to inspire others in the subject. A well stocked museum of drugs and a herbarium of drug plants and related species will be valuable helps in building up interest. Hence in the study of a specific drug, such as rhubarb, the museum may supply various forms of the drug which at one time appeared on the market in the form of "fingers," "cubes," "squares," "pieces," etc. The same applies to orris root and "fingers;" to the various commercial varieties of cardamom fruits, grades of tragacanth and other gums, varieties of glycyrrhiza, sarsaparilla, and many others. Often many of these have personal interest stories or interesting historical features that may be related at the beginning of the laboratory period.

Herbarium sheets of the drug plant will prove to be of great value, especially when the living plant is not available. At this time it should be pointed out that teachers of pharmacognosy could be of considerable mutual benefit by exchanging herbarium sheets of drug and related plants native to their particular locality with colleagues in other states. It may not be amiss, either, to require the students to make a collection of drug plants from the particular area of his residence and present them, properly labeled and mounted, as a project in the course. This assignment would at least help to develop plant consciousness in the student, since in the writer's experience the ignorance of college students concerning identity of plants is exceeded only by his ignorance of the Scriptures.

Other display material that should not be overlooked are pictures that relate to the drugs under study, printed accounts from newspapers, magazines, graphs showing import figures over a period of years, and finally proprietary items containing a particular drug currently found on the market. The latter exhibits will correlate the drug with drug store practice and thereby justify its study by the student.

Charts or graphs showing imports of drugs and drug products over a period of years may be prepared by graduate students in the course in economic pharmacognosy. Although statistics are generally cold and uninteresting, the fact that many drug products are consumed in millions of pound quantities is bound to make some impact on the student.

Finally, the value of lantern slides, movie films or filmstrips of drug production or processing should not be overlooked as an added means of arousing interest.

What might be achieved in the laboratory with the so-called biological drugs or products, such as antibiotic substances, sera, vaccines, etc., products of animal glands, etc. ? If it is true that plant drugs occur in the drug store mainly in the refined or manufactured form, it is even truer in the case of these microbiological and glandular drugs. In many schools bacteriological products are basically dealt with in the required bacteriology courses. Animal hormones are usually dealt with basically in human physiology and biochemistry. Pharmaceutical and medicinal representatives of these classes are therefore considered in the didactic part of pharmacognosy.

Specimens of these various official products (and related ones) may therefore be exhibited in original packages in the laboratory. The same treatment may be accorded to such animal products as liver extracts, insulin, blood plasma and plasma extenders, stomach, ingluvin, etc., etc. Crude glandular drugs are not common articles of commerce and, moreover, do not lend themselves to relevant laboratory study.

Laboratory offerings in pharmacognosy carried out as suggested above will contribute greatly toward the value of the course, not only in the practice of pharmacy but also as a foundation course for galenical pharmacy, pharmacology, and for the chemistry of naturally occurring organic compounds.

Some practical pointers and procedures which the writer has found workable and satisfactory in the conduct of the laboratory classes.

1. Commercial samples of the drugs to be studied for the day are placed in pint jars on the laboratory tables, one jar of each species to a table. The labels on the jars list the English name, the Latin name, the official common names, the scientific name and the family name, in the order mentioned. Students are told that they are expected to learn to identify the drug on sight, as they would an acquaintance on the street. He is not required to memorize the scientific or family names. From 5 to 8 drugs are studied per laboratory period of 3 hours, depending on the number of tests, etc. are required to be performed. The record of his experiments is entered into a laboratory manual as they are completed, and the "notebooks" are called in at any time at the discretion of the instructor.

2. The laboratory samples are left on the laboratory table from week to week so that the student may have an opportunity to look at them during each succeeding laboratory period. He is thus constantly exposed to the specimens and the names on the label so that he not only learns the official titles more easily, but even learns a few scientific names. It should be mentioned that he is required to learn the scientific names of a few of the more important drugs, especially if these names have a bearing on the quality of the drug or figure in its commercial production, such as the cinchona species and the digitalis species.

3. The student is not required to distinguish between specimens of drugs that the instructor himself is unable to distinguish between by organoleptic means, such as conium and parsley fruit, red and yellow cinchona barks, etc.

4. Museum specimens relating to the drugs under study are placed out for exhibit on a separate table, as are also herbarium sheets, pictures, live specimens of plants, etc. Also specimens of adulterants for a given drug are exhibited.

5. Laboratory quizzes are held in mid-semester and at the end of the semester.

These consist of both an "identification" or practical part and of a written part, which is designed to elicit the student's knowledge concerning the various tests applied to the drug and any other relevant material. The total laboratory grade composes one-third of the final grade in the course.

A Laboratory Method in Pharmacognosy

J. Allen Reese
University of Kansas

I was asked by the chairman to give a laboratory demonstration in Pharmacognosy. I replied that no one laboratory demonstration would illustrate my method of presenting laboratory work, but that I would be willing to illustrate how I present this phase of the work if this was satisfactory. Either through courtesy or otherwise, permission to do this was granted.

I have gradually come to the conclusion that too many experiments and tests for this and that are performed in our pharmacy laboratories. Our laboratory work is not as thought-provoking as it should be. Experiments are performed in a perfunctory manner. Results are copied out of books. Drawings are copied either from books or from other students. In short, the laboratory is a place to spend a certain number of hours performing experiments, the results of which can be ascertained in advance.

Since the above is my feeling concerning much of the laboratory work, I have tried to devise a method whereby students perform experiments with a definite purpose in mind. I believe I can illustrate the method without going into all the details of the laboratory work.

At the beginning of the laboratory work the students are informed that the purpose of the work is for each student to be able to identify any vegetable drug which is described in the literature regardless of its state of subdivision. The student will demonstrate that he is able to do this by identifying six unknown powdered drugs and two mixtures (the mixtures consist of two powdered drugs each). These drugs will be selected to see that the student has a representative knowledge of the different types of vegetable drugs. The unknowns may or may not be official. The particular ones selected may never have been official. The unknowns will be identified when an instructor is present and will represent the student's own effort. I emphasize that the preliminary experiments are designed to prepare the student for the identifications on which his accomplishments will be judged. (Parenthetically, the number of preliminary experiments which the students in my classes perform has been gradually reduced until they represent less than one-half of the total laboratory time.) The preliminary experiments assist the student in placing drugs in small groups and emphasize the importance of small differences in the final identification.

To me, obtaining the proper attitude is very important. The attitude of the student may be influenced or even determined by the experiences of previous classes. If the student can approach the laboratory work with the idea that he cannot get by with anything but definite accomplishment, his mental attitude may be such that the work will usually progress in an orderly fashion.

For several reasons, one of which is the development of the proper attitude, I use a system for my identification of the unknowns. This is based on a key using the letters of the alphabet and numbers whereby each drug can be distributed under twenty-six different designations. To make it more difficult for this key to be solved, a code word is used which must be known before a starting point for the key can be obtained. The code word is changed during the course in order to check on the efficiency of the system. To my knowledge no student has ever solved the system. Several years ago when I was using the key alone a student gained possession of the key. This student failed the course.

The purpose of the system is obviously to elminate the possibility of cheating, but from my point of view, not so much with cheating in mind as with the development of the proper attitude. I hope the student knows the work will have to be his own, and that his fellow student' s work will likewise be his own.

Close supervision is important in my method of presentation. Sections contain not more than twenty students, supervised by two instructors.

I hope you will pardon me for relating to you an incident which has influenced my laboratory teaching more than any books or courses. The last day in the laboratory of one of my undergraduate courses in the microscopic study of drugs, I chanced to look into the microscope of a fellow student who was drawing a particular structure. I could see nothing. Later, after I became an instructor, I found out why. The balsam which had been used by the manufacturer in cementing the lens had obstructed the view through the lens. The student had supposedly used this microscope throughout the course. She made an A on the laboratory work.

I personally point out to each student the key structures using the student' s microscope and sample, as well as the crystal formation and other pertinent points. If a student is in doubt about some point, assistance is freely given. The giving of information when a student has need of it is laboratory teaching, in my estimation. But the student must make the decisions himself.

My students use a key to assist them in their study. The key is not complete and it is frequently necessary to consult several books before a tentative identification can be made. An authentic sample is used for comparison as the final step.

I stated previously that the students are informed that the purpose of the course is for each student to be able to identify any vegetable drug described in the literature. The real purpose is to learn fundamental information about drugs. I use identification as a means of getting the students to acquire information. If I had as a sole purpose the identification of drugs, I would first let the students study known samples and later test their knowledge of these samples by giving them unknowns which they had previously studied. As far as I am concerned, being able to identify drugs

which have previously been studied is of little importance in the education of a Pharmacist. The fundamental training involved in being able to identify any drug is a useful educational procedure and the student also acquires information about drugs.

Some of you may wonder how I handle the identification of whole crude drugs. The way I do this may surprise some of you. No formal instruction is given. The students are told at the beginning of the course that they are required to identify the crude drugs by sight which are in open containers in the laboratory. About a hundred are so displayed. At midsemester the student is examined on the drugs studied up to this time, and a final examination on the identification of whole crude drugs is given during the last laboratory period. The students are each given a personal oral examination which takes from five to twenty minutes for each student. Ninety per cent of the drugs used in the examination must be identified by sight in order to pass the course. I have never had a student fail these examinations who, in my opinion, should pass the course. May I say that I am not interested in students learning to identify crude drugs for the sake of being able to recognize drugs by sight. I consider this relatively unimportant. However, in my experience, the identification of a vegetable drug is the easiest way to learn several things about it. It takes so little time that I have the students learn the drugs on their own time. I have found it valuable as a starting point, for the student has a mental picture that he can associate with the name of the drug. I consider it of no importance if the student at some future date cannot identify drugs by sight, or if the student never has an occasion to identify a drug in the practice of his profession. If identification has been a useful educational tool, it has well served its purpose.

Contribution of the Laboratory Instruction to the Objectives of Pharmacognosy

M. R. Gibson
Washington State College

I am very glad to have the opportunity to discuss the scope of laboratory achievements in undergraduate pharmacognosy. It's a subject about which I have very strong feelings. There is nothing more disheartening to me than to have a colleague in the teaching profession or a practicing pharmacist berate pharmacognosy. And I think they exhibit this proclivity for deprecation because they received inadequate, uninspired instruction in it themselves. Further, I believe the locus of this dereliction is very often--at least in a large measure--traceable to laboratory instruction. Pharmacognosy is a science of living things. It possesses an inherent élan vital that must strike a responsive chord in the student who by his very nature is interested in those things animate.

It has been said that study is a name for co-operation in thought and action. We might imagine co-operation of thought as that which occurs during a lecture; co-operation of action, the laboratory accomplishments. I like this definition of study because of the word "co-operation." No laboratory instruction can fully succeed unless there is contagious, enthusiastic co-operation of thought between students and instructor, and between students. The immediate question is, "How can this be achieved?"

The answer is multiplex. First, I believe that there are definite idiosyncrasies which are peculiar to pharmacognosy laboratory instruction as compared to other phases of the pharmaceutical curriculum. These singularities must be recognized by pharmacognosists and institutional administrators as well. Teaching in a pharmacognosy laboratory requires the services of specialists, specialists trained not only in pharmacognosy and pharmacy, but also individuals with experience in the study of advanced biochemistry, plant anatomy, plant physiology, and plant taxonomy. Without this prerequisite training, coupled with vigorous interest in the subject material, the laboratory instruction fails in its ideal purpose. A graduate student who is not advanced in graduate training in pharmacognosy is not capable of teaching in a pharmacognosy laboratory. We use the term "laboratory assistant." Too often this is an academic term for cheap laboratory instructors. There is a place for laboratory assistants in pharmacognosy; but they are, in most instances, not capable of laboratory teaching. To most schools this presents a serious problem. There are very few schools which have advanced graduate students in pharmacognosy available for laboratory teaching; hence, the burden falls on the trained professors of the subject. The State College of Washington has long had the reputation of producing high-caliber graduates who excel in the techniques of the profession. This is principally due to great stress on professorial participation in laboratory teaching. We must all agree that pharmacy is a laboratory science; yet, too many schools fail in their recognition of the importance of sound laboratory instruction. In our didactic work in pharmacognosy, we teach so much that must be borne out by laboratory study, I see no successful way of accomplishing this, other than by a unity of teaching--

laboratory and lectures, accomplished jointly by an instructor or instructors. The results of such an integration are stimulating and successful.

In the pharmacognosy laboratory, broad experience and study in the field by the instructor are imperative to provide intelligent interpretations and explanations of student observations. The difference between a properly, intelligently run laboratory and one that is not is the difference between the success and failure of this, the applied phase of the discipline.

I stress this point of competent laboratory instruction here because it is of obvious relevancy to student achievement. The scope of achievement is proportional to scope of instruction; and to maintain the achievements on a high level, the subject must be taught on a high level. When the factual information is presented in an interesting fashion by a competently trained instructor, the student response reflects the enthusiasm and success of the instruction. Therefore, I believe that the most important requisite for student achievement in the laboratory is a well-taught laboratory.

As to the scope of the material to be taught in a pharmacognosy laboratory, there is much divergence of opinion. If I were asked what I taught in laboratory, I would immediately reply, "As much as possible." My teaching experience in the Army proved to me the amazing amount of material that could be projected into the minds of people if they could see, hear, feel, smell, and even taste what they were being taught. The same is true in pharmacognosy, the laboratory offers a tremendous opportunity to expatiate students' knowledge and to give them a truly cultural grasp of the subject. I teach pharmacognosy using the phytochemical approach. The laboratory work therefore involves phytochemical tests for identity, purity, and in some instances micro-isolation of principles. However, I think it would be derelict not to include a careful study of gross anatomy and the salient microscopical elements of the drug. I think the biochemical tests are too obvious to expand upon here. The students are adequately prepared in chemistry, and the tests present little difficulty. Ingenuity in presenting tests in a novel way may enhance their interest, such as demonstrating active principles in tissues and demonstrating extraction techniques on a larger scale. These procedures will help to impress upon the student the character and position of the active constituents of a drug.

The study of the gross anatomy of a drug, of course, is of considerable importance. Here, the use of stereoscopic microscopes and slide projections of the dissected drug is of extreme value. In the study of small seeds and fruits, for example, the use of the stereoscopic microscope gives the student a true picture of those properties which are peculiar to it, and the dissected parts imbue these properties with significance. When it is not practical to do individual dissections, demonstrations of dissections, and photos and drawings of dissections are valuable. The study of the gross anatomy of the commercial form of many drugs, for example, some of the leaf drugs is most frustrating to the student. Drugs that do not retain their original form in commerce must be studied from fresh and specially prepared samples. Hyoscyamus is an example of a drug which usually occurs on the market in a crumbled mass.

Here, pressed specimens made from the growing plant should be supplied each student, so that he can intelligently visualize the fragments of the commercial sample as part of a definite whole. Whenever possible the growing plant should be brought to the laboratory from the greenhouse in the potted state, to demonstrate how the drug is a part of a specific living thing. Experience in timing of greenhouse planting will make possible the presentation of a plant in the laboratory at a time it best illustrates the part of the plant used as a drug. To bar against unforeseen difficulties it' s always wise to have pressed herbarium specimens available.

The utility of a microscopical study of drugs by the student will possibly be disputed by some of you who also teach on a phytochemical basis. Again I say, the capabilities of a student in the laboratory are surprising if the material is presented simply and logically. I think it' s important that the student see the various microscopical elements of drugs. I present cross-section mounts by demonstration only, to integrate the individual elements. Slides of microscopical elements are kept in continuous projection at the front of the laboratory, so that the student can always be aware of the elements he is to find and also visualize the relationship of the element or part of an element that he sees in his own microscope as compared to the ideally drawn or photographed unit in the projection.

I believe with such a presentation as I have outlined above, the scope of the student' s knowledge of a drug has been given every opportunity to expand.

To summarize, I believe the latitude of presentation of laboratory material must not be curtailed through inadequate teaching by improperly trained personnel. Further, the material should be presented in such a way that the general and particular properties of the drug as part of a class and as an entity are demonstrated; yet, care should be taken that the other elaborative phases of the study are not forgotten. For these tend to integrate the aggregate of information into a unified totality.

Specific Laboratory Subject Matter in Pharmacognosy

J. Hampton Hoch
Medical College South Carolina

In our panel presentations of laboratory exercises in pharmacognosy we presume that the laboratory work will be integrated with the didactic instruction and that principles and applications previously presented to the class can be illustrated by the laboratory work. The materials we use for such exercises need not be important from a therapeutic or pharmaceutical point of view; indeed, the therapeutic graveyard may supply a skeleton for a lively experiment if the muscle-meat of principles is tied to it by the sinews of imagination.

We want to aim in our laboratory course for: 1) accuracy of observation and precise recording of data, 2) correlating information gained with what is already known, 3) systematizing data and interpreting it so as to draw logical deductions from it, 4) training in orderly mental habits.

Every laboratory exercise will not accomplish all these objectives equally well. But the total aim can be achieved by the whole series of exercises in the course.

As an example of laboratory work applied to Ipecac, which is one of the first drugs presented in our course:

The student is given samples of Rio and Cartagena Ipecac for macroscopic comparison. He has been assigned reading references on the assay of ipecac, on the decomposition of emetine, and on differential histological characters of the commercial varieties in addition to the textbook material dealing with ipecac and amebacides.

1. A demonstration is set up under the ultra-violet lamp of (a) whole Rio Ipecac and freshly fractured pieces, (b) powdered Ipecac, (c) emetine hydrochloride.

   The directions are to examine and note the characters shown by these materials.

2. He is directed to carry out color tests with powdered Ipecac using: (a) Potassium chlorate. Mix 100 mg. powder with 5 cc hydrochloric acid (4:1), filter. To 1 cc filtrate add 5 mg. potassium chlorate. (b) Calcium hypochlorite. Shake 200 mg. powder with 2.5 cc dilute HCl, filter. To a drop of filtrate add a granule of calcium hypochlorite.

   Examine these tests at intervals during the period.

3. He examines transverse and longitudinal sections of either Rio or Nicaraguan Ipecac for histological characters, noting the contents of cortical parenchyma, the ratio of xylem to total diameter, the

types of conducting and lignified elements in the xylem. These sections are mounted in (a) iodine water, (b) chloral hydrate with warming, (c) phloroglucin-HCl.

Alternate students select the same variety and neighbors compare results and swap mounts.

4. He next examines powdered Ipecac in a 10% glycerin mount and is directed to measure ten of the largest simple starch grains and to draw several 3- and 4-compound grains.

   Questions to be answered from observations of the sections and powder are: What are the characteristic features of this drug? Could you distinguish Rio and Nicaraguan varieties on the basis of your observations?

5. He is asked to demonstrate alkaloids in powdered Ipecac by carrying out a microextraction using ammoniacal chloroform. The evaporated residue is dissolved in dilute HCl and precipitated with acidified picric acid (1 volume saturated aqueous picric acid and 5 volumes 3% HCl).

The Use of the Medicinal Plant Garden as a Teaching Aid in Pharmacognosy and Related Subjects

Heber W. Youngken
Massachusetts College of Pharmacy

A well organized medicinal plant garden is of great value to the teachers and students alike in colleges and universities offering courses in pharmacognosy, plant chemistry, botany, and related subjects. Its potentialities as an aid to the effective teaching of these subjects is almost boundless.

The uses of the medicinal plant garden are many and varied depending upon the plants grown, the courses offered by the institution, and the care given to its upkeep. A well organized drug garden of a College of Pharmacy should contain a good representation of medicinal, allergenic, insecticidal, aromatic and other economic plants which can be grown outside in the area of its location. With certain limitations varying with the climate and soil prevailing in a given locality, it is possible to grow a large variety of these plants.

Among the specific uses of such a garden as an aid to the teaching of pharmacognosy and related subjects are the following:

(1) To acquaint students with the living drug, insecticide, rodenticide and other economic plants, and especially the outstanding of those whose products are discussed in their college courses.

(2) To provide fresh plants and parts thereof for use in the laboratory and lecture. To the average student fresh plant material is more inviting to study than dried or preserved specimens. In the study of plant physiology and plant taxonomy it is imperative.

(3) To demonstrate to classes the characteristics of groups, especially families and classes of plants. By grouping the different species in family beds as far as practicable, demonstrations may be given of outstanding family characteristics in a relatively short time. In most of the localities where Colleges of Pharmacy exist in America it should not be difficult to grow a sufficient number of plants of different species of the Gramineae, Liliaceae, Ranunculaceae, Cruciferae, Rosaceae, Leguminosae, Labiatae, Scrophulariaceae, Solanaceae, and Compositae to fill up at least one good sized bed of each of these important families. In some areas other family beds could readily be filled with a number of medicinal and related species in each of them. Ornamental shrubbery and trees including many of medicinal interest could be placed around the border of the garden and interspersed in areas between the beds to enhance the beauty of the garden.

(4) To provide students with practical training in growing, cultivating, harvesting and drying of medicinal and other economic plants. In the course of drug plant cultivation, it would be difficult for the teacher to get along without this important asset.

(5) To provide sufficient readily accessible plant materials for use in research problems in pharmacognosy, plant anatomy, plant chemistry, plant physiology and genetics. What a convenience to have close by a garden where one can often grow so much dependable plant material for the classroom and research.

I believe every teacher of pharmacognosy and related subjects who has attempted to inspire his or her students with real interest in these subjects and who, like the speaker had taught these subjects for years before having access to a medicinal plant garden will, once such a garden is obtained and used, witness a miraculous change in the attitude of his students toward these subjects and in the consequent effectiveness of his teaching. Edson Bastin is said to have often told his classes in Botany, "Study Nature first, not books."

While both kinds of study are necessary in learning the natural sciences, Bastin wanted to emphasize the place for most emphasis. There was some good philosophy in those utterances, for, if we are to put these subjects across effectively, we must constantly confront the student with illustrative material. Herbarium sheets, charts, lantern slides, dried drugs and blackboard sketches are all helpful aids in their teaching and better than words alone, but living, growing medicinal plants will linger longest in the student's memory.

Antibiotics in the Pharmacy Curriculum

Robertson Pratt
University of California

As teachers of future pharmacists we, unlike those teaching in some other professional areas, have a unique opportunity to spread the effects of our teaching far beyond the comparatively few students who attend our classes. The pharmacist more than any other member of the community is in a strategic position to disseminate information concerning drugs, since he contacts both the physician and the layman in a professional capacity. It is incumbent upon us, the teachers, to see to it that he is qualified to disseminate reliable, contemporary information intelligently.

It is axiomatic that education should keep pace with the times. Therefore, it seems only logical that curricula and course content should be revised from time to time and that in planning these and determining the amount of time to be devoted to different subjects, consideration should be given to the relative importance of the different classes of medicaments and services the pharmacist will be called upon to dispense. No matter from what point of view one looks at the training of pharmacists, antibiotics demand signal attention.

Antibiotics and related products intended for internal use comprised 18 per cent of all prescriptions filled in the United States during 1952; the dollar value of these prescriptions ($258,128,000) comprised 26.1 per cent of the total value of the prescriptions filled during the same period.

In terms of percentage of prescriptions filled, the antibiotics were called for twice as often as sedatives and hypnotics (including barbiturates); more than three times as frequently as vitamins, cardiovascular drugs, or analgesics; and about six times as frequently as hormones.

Figures such as these cannot be ignored.[+] The sad part of this picture

[+] Data from American Druggist, March 2, 1953, 127:(5):5-9.

is that much of it represents abuse or misuse of antibiotics. Often antibiotics are prescribed for conditions in which they cannot possibly do any good and, in fact, may even be detrimental. Even when the infection to be treated legitimately calls for an antibiotic, frequently the drug is prescribed to be dispensed with other agents which either impair or completely nullify the effectiveness of the antibiotic. It is discouraging to note the frequency with which doctors write for antibiotic preparations that can have very little antimicrobial effect by the time they reach the patient. For instance, it is not uncommon to find prescriptions calling for penicillin dispensed in H_2O_2, in $ZnSO_4$, solution, or in neosynephrine. The pharmacist should be aware of the inactivating effect of peroxides and of zinc on penicillin and be in a position to discuss these matters with the doctor. Neosynephrine with a pH of approximately 5.0 can do naught but inactivate the antibiotic. The

half-life of penicillin at pH 5.0 at room temperature is only about one fourth the half-life at pH 6.0 to 7.0.

I cite these merely as examples. It would be impossible to recite or to anticipate all the weird and impractical combinations that have been or that might be called for. The important point is that the pharmacist should be so familiar with the chemical, the physical, and the biologic properties of the different drugs with which he deals that he can recognize unsound preparations and offer advice to the physician on how to achieve maximum therapeutic benefit from the medicaments the doctor deems indicated.

Knowledge of drugs should not be confined merely to their physical and chemical aspects. Nor will mere familiarity with the official and proprietary forms in which drugs are available enable the pharmacist to meet his professional obligations properly and to be of greatest service to the community. The pharmacist is the logical person for physicians, health officers, and laymen to consult for information concerning all aspects of drugs. To satisfactorily discharge this obligation, he must possess basic and fundamental knowledge of the principles that underlie production and use of various drugs. He must know what lies behind the label on the package. The pharmacist must understand the principles (and pitfalls) as well as the benefits and limitations of antibiotic chemotherapy. He must be familiar with the numerous factors that can and do modify the therapeutic effectiveness of antibiotics. These factors are by no means limited exclusively to the nature of the infection under treatment and to the condition prevailing in the pharmacy or hospital storage quarters before administration of the drug, or in the ward or doctor's office at the time of administration.

In most schools, some information concerning various aspects of antibiotics is currently given in the regular courses in Pharmacognosy, Bacteriology, Dispensing, etc. But so important a subject as antibiotics cannot be treated adequately by merely "sandwiching" a few facts into already established courses. Such a procedure is bound to slight some important aspects of the subject and, more important, fails to give the student a comprehensive and integrated view of the subject.

The solution to this problem is to establish a separate course (or courses) devoted to the subject of antibiotics. The questions to be answered are not "Shall we offer a course in antibiotics?" or "Should the course be prescribed or elective?" The questions are "When in the curriculum should such a course be prescribed to be of greatest value to the student?", "How much time should be devoted to it?", and "What should its content be?"

Ideally, the student should have some knowledge of bacteriology, organic chemistry, physical chemistry, and pharmacology before embarking on the study of antibiotics and the general phenomenon of antibiosis. However, to demand all of these subjects as prerequisites would preclude students from taking the course in most schools that are operating on a four-year program.

The course can be given with advantage in any year of the pharmacy

curriculum after the student has acquired familiarity with elementary organic chemistry and with a few simple biological principles. Naturally, the value derived by the student from the course will vary directly with his knowledge and understanding of biological and chemical facts and concepts and, therefore, in a four-year program, the course in antibiotics preferably should come in the senior year or, if this is impracticable, in the junior year.

It is difficult for an administrator to decide how much time should be devoted to a new course, especially in an already crowded curriculum in which instructors in already established courses often are clamoring for more time. Some may feel that the course in antibiotics should be reserved for a five-or six-year program. At the University of California we do not agree with this view. We believe that the course in antibiotics is so fundamental that all future pharmacists should have the benefit of such a course, even if this necessitates reducing slightly the time spent in some other areas of instruction.

In the regular four-year program at the University of California College of Pharmacy we offer two one-semester courses devoted to antibiotics. One is a prescribed three-unit lecture course in which current factual knowledge is related to the basic principles and theories upon which the whole realm of antibiotics, from production to ultimate application of the drugs in medicine and pharmacy rests. The other, for which the prescribed course is a prerequisite, is a two-unit elective course in which more advanced problems involved in the industrial, chemical, biological, and clinical aspects of antibiotics are studied and discussed.

An obvious question concerns the course content. What should be included and what should be stressed? Naturally, each instructor will have his own ideas concerning answers to these questions and there will be variations from one course to the next. The following outline is one which we have used successfully for several years in our prescribed course.

Part I. Fundamental Aspects

A. Antibiosis and Antibiotic Spectra
   1. The Concept of Antibiosis
   2. Natural Sources of Antibiotics
   3. Criteria for Identification of Antibiotics
   4. The Concept of Antibiotic Spectra

B. Biologic Significance and Fields of Diffusion
   1. Mutual Relations Among Organisms
   2. Significance of Fields of Diffusion
   3. Modification of the Sigmoid Curve by Growth Accelerators or Inhibitors
   4. The Concept of Threshold and Optimal Concentrations

C. Antibiotics and Chemotherapy
   1. The Concept of Chemotherapy
   2. Requisites for an Ideal Antibiotic

Part II. Industrial Aspects
- A. Industrial Production of Antibiotics
  - 1. Production by Fermentation
- B. Screening and Assaying Antibiotics
  - 1. Screening Tests
  - 2. Assaying Antibiotics

Part III. Applied Aspects
- A. Penicillin
  - 1. Penicillin as a Chemical Compound
  - 2. Penicillin as a Chemotherapeutic Agent
- B. Bacitracin, Subtilin, and Tyrothricin
  - 1. Bacitracin
  - 2. Subtilin
  - 3. Tyrothricin
- C. Streptomycin
  - 1. Streptomycin as a Chemical Compound
  - 2. Streptomycin and Dihydrostreptomycin as Chemotherapeutic Agents
- D. Viomycin, Neomycin, and Polymyxin
  - 1. Viomycin
  - 2. Neomycin
  - 3. Polymyxin
- E. Chloromycetin, Aureomycin, and Terramycin
  - 1. Chloromycetin (Chloramphenicol)
  - 2. Aureomycin and Terramycin
- F. Erythromycin and Carbomycin
- G. Mixed Antibiotic Therapy
  - 1. Principles of Mixed Antibiotic Therapy
  - 2. Some Indications and Contra-Indications
  - 3. Conclusions
- H. Antibiotics in Dental Practice and Oral Surgery
  - 1. Penicillin
  - 2. Bacitracin
  - 3. Aureomycin and Terramycin
  - 4. Streptomycin
  - 5. Chloramphenicol
- I. Antibiotics in Agriculture
  - 1. Veterinary Uses
  - 2. Antibiotics as Growth Stimulants
  - 3. Antibiotics in Plant Pathology
  - 4. Antibiotics in Food Processing

Part IV. Modification of Biologic and Social Systems
- A. Emergence of Resistant Strains of Micro-organisms
  - 1. Significance of Resistant Strains in Antibiotic Therapy
  - 2. How Resistant Strains Arise
  - 3. Antibiotic-Dependent Strains
  - 4. The Problem of Cross Resistance
  - 5. Curtailing Development of Resistant Strains in vivo

Part IV. Modification of Biologic and Social Systems (continued)

B. Mechanisms of Antibiotic Action

1. Distinguishing Characteristics of Antibiotics
2. Penicillin
3. Streptomycin
4. Chloromycetin
5. Aureomycin and Terramycin
6. Tyrothricin (Gramicidin and Tyrocidin)
7. Mechanisms of Action, Sensitivity, and Resistance

C. Some Social and Economic Aspects of Antibiotics

Discussion of Part I is intended to establish in the student's mind the fundamental concepts and principles involved in man's adaptation of natural antagonisms among micro-organisms to serve his own purposes. In Parts II and III specific factual information concerning the different antibiotics is discussed in relation to the principles established earlier in the course. Each clinically useful antibiotic is discussed as a microbiological product; as a chemical compound; as a chemotherapeutic agent, including its pharmacology, and factors influencing its usefulness, etc.; and as a pharmaceutical entity.

Part IV draws on information and ideas presented in the earlier parts and develops a broad concept of the significance of antibiotics in the physico-chemical and bio-economic aspects of life. The material in sections A and B gives the student an insight into biochemical means by which different antibiotics affect bacterial and animal metabolism. The importance of differential cytotoxicity is stressed. Section C deals with the broad demographic aspects of antibiotic therapy and their impact on the social and economic phases of our community and family life. Much attention is given to the changing population structure and its implications for the future.

This program, which has cultural educational significance as well as professional value, is well beyond the experimental stage in our college. The course has been operated to the extreme satisfaction of both students and faculty since 1944 under the aegis of the Pharmacognosy division.

Immunizing Biological Products

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Before discussing the individual immunizing products, I would like to mention the classification of the different agents according to their nature.

Vaccines consist of active antigens which upon parenteral application stimulate the production of antibodies. In all cases, attenuated, inactivated or killed organisms are used, for instance in small pox, rabies, Rocky Mountain fever, etc.

Antisera consist of serum containing the antibodies against a given antigen, produced by another host. In some cases only the antibody containing blood fraction gamma globulin is used, for example in measles, hepatitis and recently in poliomyelitis.

Antitoxins consist of serum containing antibodies against a given toxin but not against the microorganism itself. The antibodies are produced in another host. Examples of antitoxins are diphtheria, botulism, tetanus, etc.

Toxoids are toxins rendered inactive by chemical procedures and stimulate the production of antitoxins by the host. Toxoids are used in the prevention of tetanus and diphtheria.

I shall, in the following presentation, restrict myself to the discussion of the more important immunizing agents.

The practice of vaccination for the purpose of preventing disease is a very old one. A Hindu physician named Dhanwantary, who lived about 1500 years B. C., gave the following account:

" One takes vesicular fluid from the cows teats or from the arm of a man between the shoulder and the elbow with the aid of a sharp scalpel, and scarify with the contaminated scalpel the skin of the arms between shoulder and elbow until blood appears. When the fluid on the scalpel is mixed with the blood, pox fever occurs. "

This Hindu physician was undoubtedly describing small pox vaccination. The scientific documents left by Dhanwantary fail to indicate whether or not he vaccinated humans against small pox. In a constant effort to conquer small pox, numerous " medicine men" have tried to vaccinate and thus prevent the dreadful disease.

It was not until 1796 when Edward Jenner, a British physician vaccinated the first human being successfully against small pox. Utilizing the observations of other people that individuals who became infected with cow pox never became

infected with smallpox, he demonstrated that surviving a cow pox infection actually protects against small pox.

Today, small pox vaccination is widely used and a safe, dependable vaccine is available. The vaccinia virus (formerly called cow pox virus) is grown successfully on calf skin; it produces pustules containing a mixture of lymph fluid and virus. The content of the pustules is harvested, glycerine and phenol are added to preserve the preparation and destroy contaminating microbes. Sterility and potency tests are carried out before the vaccine can be used. It is interesting to note that small pox is the only virus consisting of several antigenic components. An enormous amount of work has been done along that line; however, the exact antigenic structure of vaccinia and small pox virus and the relationship between the two viruses is still not clearly understood.

Since small pox prevention is truly a vaccination, we must remember that all we do is introduce an active antigen but the antibody must be produced by the host. We must furthermore realize that we experience an actual vaccinia virus infection, which is usually associated with a fever response, in order to acquire an immunity against small pox. Complications occur relatively seldom but are probably responsible for the reluctance of many people towards small pox vaccination.

The theoretical background and the production of Rabies vaccine is interesting enough to justify a relatively detailed discussion.

The great French chemist and bacteriologist, Louis Pasteur, tackeled the problem of rabies vaccination around 1880 after a veterinarian named Bourrel drew Pasteur's attention to the problem. After obtaining a specimen from a hydrophobic child, he went to work on laboratory animals and came soon to the conclusion that rabies virus lost its activity upon repeated transfers in rabbits. He also observed that brain specimens from infected dogs produced rabies in subsequently inoculated dogs. He concluded that the virus occurs not only in saliva but also in brain of infected dogs. Further investigations led to the successful vaccination of dogs. Pasteur was very hesitant in the use of his vaccine in humans; but he made the decisive step when a mother brought her son who was severly bitten by a dog. Pasteur gave several injections of his vaccine and after reporting the case at a meeting of the French Academy of Sciences on the 21st of October, 1885, the vaccination was officially declared successful.

The preparation of the rabies vaccine at the present time is still according to Pasteur's prescription. He called the virus, as it is isolated from a case of rabies, STREET virus. The STREET virus is extremely pathogenic for man. Upon a number of passages of the virus through rabbits, the virus loses gradually its human pathogenicity but its antigenic properties remain unchanged. The attenuated virus was then called " virus fixe." This virus fixe preparation is now used successfully to prevent rabies; it is administered, however, only after a known exposure. Since the vaccine is obtained from rabbit brains, it contains of course nervous tissue which might cause dimyelinization.

The idea of attenuating a given microorganism by passing it through an unnatural host has been utilized successfully in producing other vaccines such as influenza, various rickettsiae, and others.

Influenza epidemics occur periodically all over the world. A suitable preventive measure would therefore be highly desirable. As I pointed out in a previous paper, influenza occurs in three antigenically different types, which means a polyvaccine protecting against the three types would be needed. Because of the interference phenomenon, whereby one type suppresses the others if present in an excess amount, such a polyvaccine is not effective. Vaccines against the individual types are obtained from the infected allantoic fluid of the embryonated chicken egg. These vaccines are not very valuable for epidemiological reasons. No one can predict the virus type which will cause a given epidemic. Vaccination after the epidemic is established, is not very effective, because most people have then been exposed.

A vaccine which is now under investigation, and its outcome eagerly awaited by the peoples of all nations, is that against poliomyelitis. Considering that this disease exists since about 3500 years B. C. and the enormous amount of data collected, it makes one wonder why a polio vaccine was not developed earlier. The difficulties arising in relation to polio research towards the development of a vaccine were enormous. It was found that the pathogenicity and antigenicity were tied together, which means the virus upon inactivation also lost its antigenic property. Furthermore, the only source of the polio virus was spinal cord of infected monkeys. Some years ago it was finally found that monkeys could be vaccinated against polio if a given technical procedure was used. Then the problem of antigenically different types arose. A thorough investigation as a cooperative research project in which four universities in this country participated (among them the University of Utah) resulted in the establishment of three immunologically different types. The three so-called prototypes are now called Brunhilde (Type 1), Lansing (Type 2), and Leon (Type 3). Vaccination studies in monkeys, using all three types individually, soon showed that about 20 out of one hundred monkeys inoculated with Type 1 virus became paralyzed as a result of the vaccination. The turning point came when John Enders from Harvard University announced in 1950 the successful cultivation of polio virus in tissue culture, using extraneural tissue.

Subsequent studies proved the successful propagation of all three polio virus types in a variety of tissues, such as monkey testicles, liver, kidney, intestine, and recently in tissues of malignant tumors. The virus can easily be harvested from the culture tubes and it contains a negligible amount of foreign proteins which might have become a serious problem in the repeated inoculation of the vaccine. After the virus is inactivated with formaldehyde it is mixed with an adjuvant such as mineral oil to allow only a gradual release of the antigen after its introduction into the body. This type of vaccine has been used successfully in monkeys. Recently about 200 people were given this vaccine successfully, judging from the results of antibody-response studies. The ultimate proof of the success in polio vaccination will be when those vaccinated people become exposed to the natural infection without developing the disease. It is planned by the Polio Foundation to sponsor a field trial by vaccinating one

million children across the United States. If everything turns out the way it is expected, the vaccine will be made available for general use within the next few years.

The development of this vaccine is not only a tremendous scientific achievement it is also a shining example of the fruitfulness of cooperative research.

Bacterial infections which can be prevented to a certain extend by immunization include Diphtheria, Whooping cough, Tetanus and all three forms of Typhoid Fever. A so-called triple vaccine is available and widely used to prevent Diphtheria, Tetanus and Whooping cough. The preparation consists of a mixture of killed Hemophilus pertussis, Diphtheria and Tetanus toxoids. Although the value of the triple vaccine is generally recognized, doubt is frequently expressed as to the complete protection, especially against whooping cough.

A triple vaccine is also available for immunization against Typhoid fever. The vaccine consists of a suspension of killed Salmonella typhi and Salmonella paratyphi A and B. The vaccine has been used successfully for many years. It is felt that three subsequent injections provide an adequate immunity for several years.

There are vaccines available for several other bacterial infections such as Undulant Fever, Tularemia, Cholera, Dysentary, Plague and others, which will not be discussed at this time.

Most Rickettsial infections can now be prevented by means of vaccination. A highly effective egg vaccine is available for Rocky Mountain Spotted Fever. Three initial injections are required and an annual booster injection should be given to maintain the immunity. Classic and murine typhus fever can also be prevented by means of an egg vaccine. The immunity is however of relatively short duration and does not, in the case of classic typhus, protect against an infection through the mucous membranes.

A vaccine against Scrub typhus is available in the form of a lung suspension from infected rats. This vaccine has been used with great success in immunizing combat troops in Korea and the occupation forces in Japan. This disease which occurs primarily in the Far East has taken a tremendous toll among North Koreans and Chinese troops to whom this vaccine is evidently not available.

Several of the immunizing biologicals which I have just discussed serve also purposes other than the prevention of infectious disease. They are used as an aid in diagnostic work and also in the determination of the sensitivity of an individual to a given infection. Especially toxins or antitoxins are used as skin test materials. The classical example is the Schick Test for Diphtheria, by which certain amounts of toxin are injected intradermally and depending on the outcome of the reaction indicating immunity or susceptibility to the disease.

In conclusion, I wish to make some general remarks in relation to immunizing biologicals:

1. The most desirable type of a vaccine is the one containing no significant amounts of foreign protein, unless one vaccination will suffice to provide an immunity for a long period of time.

2. Egg vaccines have been used successfully for many years. They are, however, not suitable for mass-vaccinations because of a relatively high incidence of allergic reactions due to egg protein.

3. The search for new and better therapeutic agents should not supercede our efforts to develop more and better immunizing agents.

Allergy and Allergens

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The subject of allergy and allergens is rapidly becoming a science in its own right. Formerly considered a minor branch of internal medicine, allergy with its many ramifications now represents the subject matter of numerous post-graduate courses for physicians. Depending upon his inclination and the time available the physician may attend a 1- or 2-day meeting, a 1-week session, or a 1- or 2- year course leading to a post-graduate degree. If he devotes half of his practice to the treatment of allergic diseases, he may become a member of one or both of the national allergy associations as well as a member of the state and regional societies. All of these organizations offer instruction in the various phases of allergy and the attendance at the meetings is growing annually. To keep abreast of this trend in the medical profession, the pharmacist should possess sufficient knowledge of the subject to enable him to converse intelligently not only with his physician associates, but also with his own customers in his retail pharmacy. Often the customer relates his symptoms to the pharmacist before consulting a physician; frequently, he seeks additional advice after the consultation. The retail pharmacist, then, has an unusual opportunity to utilize whatever training he may receive concerning allergy, its causes, and its prevention or treatment.

Since the majority of allergens stem from the plant and animal kingdoms, their consideration falls within the realm of pharmacognosy. It may be claimed that the subject of allergy in general is a part of the course in bacteriology or microbiology inasmuch as the allergic phenomenon is based upon certain phases of immunologic response, particularly the antigen-antibody reaction. However, lack of time prevents complete coverage in a bacteriology course; in addition, the emphasis is chiefly concerned with the immunity, or rather, the lack of immunity, which develops. If bacteriology or microbiology precedes pharmacognosy, the teacher of the latter subject may build upon the principles of allergy that the student has already gained; but, he should stress the practical applications to the pharmacist.

Instruction in allergy should provide a broad, basic background for a proper understanding of the underlying principles. It should include general information about the importance of case histories, diagnostic skin tests, and methods of treatment as well as specific information on the types of allergens, how they may be avoided or eliminated, their relation to the production of symptoms, how allergenic extracts are prepared, their methods of assay, and other pertinent details.

The theoretical consideration of allergy which should be emphasized for the pharmacy student is mostly factual and describes the clinical routine of the allergist, nevertheless it is essential that the practicing pharmacist possess this knowledge to meet his professional colleagues on common ground. The pharmacist's answers to the laity can accomplish much in building or destroying the confidence which his customers may place in him. For instance,

the matter of recording a case history is of great concern to the allergist since not only the type of symptom but also the time of year or the interval between attacks is of prime importance. Certainly, the type of symptom will enable the allergist to determine with a fair degree of accuracy whether the allergen is a food, an inhaled particle, a skin contactant, or another type of antigenic substance. Food allergens manifest themselves in the form of urticaria, dermatitis, gastro-intestinal disturbances, or even severe headache including migraine. Inhalant allergens produce seasonal hayfever or perennial allergic rhinitis indicated by sneezing, lacrimation, bronchial asthma, or persistent recurring cough. Skin contactants cause dermatitis, urticaria, and eczema.

In cases of hayfever the time of occurrence of the allergic attacks is significant. If the symptoms begin in the early spring and are over before May 30, the pollinating flowers of trees are implicated as the causative factors. If the symptoms appear between May 30 and July 4, an allergy to grass pollens or to plantain pollen may be suspected. If the allergic reactions occur after August 1 and continue until the end of the flowering season, weed pollens, particularly the ragweeds, are probably responsible. However, if the symptoms appear throughout the year without a definite seasonal trend, a mold allergy, a dust allergy, or an allergy to epidermals is apparent.

Following the recording of the case history the patient will undergo a complete physical examination by the physician. The pharmacist can assist in conditioning the allergic individual for this and other tests. Skin tests are pre-ëminent among the diagnostic aids which reveal the offending allergens. There are two schools of thought on the proper method of conducting skin tests: those who prefer the scratch test and those who use the intradermal test. Regardless of the method used, the end results are somewhat similar being characterized by a wheal with pseudopod formation surrounded by an erythematous area. The results are interpreted as negative, 1-plus, 2-plus, 3-plus, and 4-plus, the latter figure indicating the most severe response. Skin tests disclose inhalant, ingestant, injectant, and contactant allergens. The test materials represent the antigenic factors of pollens, mold spores, dusts, feathers, dander, fur, perfumes, nail polishes, face powders, lipsticks, and practically every type of food imaginable.

Hyposensitization treatment involves the parenteral injection of therapeutic extracts. In hayfever cases the method depends upon whether the patient sees the allergist early or late in the season. Treatment is termed co-seasonal if the injections are given during the hayfever season; it is pre-seasonal if they are given prior to the season; and it is perennial if the injections extend throughout the year. Injections of allergenic extracts do not cure the patient's condition but rather decrease his sensitivity. A complete course of hyposensitization treatment will usually raise the patient's threshold of tolerance for the allergen to such a degree that his discomfort is almost completely eliminated.

Although anti-histamine drugs have brought relief to many hayfever victims they are merely considered palliative agents. If the patient wishes to buy anti-histamines over-the-counter rather than on a physician's pres-

cription, the pharmacist should warn him of the potential dangers of continued promiscuous use of such substances. Since the basic mechanism of action of his allergy is not prevented but merely masked, it is possible that he may build an increased sensitivity to the allergen leading to serious forms of asthma. Anti-histamine therapy is not to be construed as preferable to the hyposensitization method of treatment. Here, once again, the retail pharmacist must emphasize the hazards of self-medication.

The foregoing information supplies background knowledge for the pharmacy student and practitioner. In discussing interrelationships and correlations among pharmacognosy and the other professional courses in the pharmaceutical curriculum, the pharmacognosy teacher should call his student's attention to the manufacture of allergenic extracts which may be conducted in the course in hospital pharmacy or in manufacturing pharmacy. He should stress the methods of assay of allergenic extracts, particularly the protein nitrogen or the total nitrogen, by either the Kjeldahl or the semi-micro Kjeldahl method undoubtedly considered in the course in pharmaceutical chemistry. The implications of allergic reactions are related to the course in pharmacology in that the shock tissues are reacting to histamine or, at least, to a histamine-like substance.

There are numerous interesting laboratory procedures which can be conducted in the pharmacognosy laboratory instruction. The student may be instructed in the means of identification of the variety of allergenic materials. This, again, is basic knowledge of a specific type that may or may not be used in actual practice by the pharmacist but which can serve as a valuable source of information for improving physician-pharmacist-public relations.

Every student of pharmacognosy should be able to identify the chief cause of contact dermatitis, poison ivy (Rhus radicans L.) in view of the illustrative material depicted in trade journal advertising, in manufacturer's descriptive literature and, particularly, because of the prevalence of the living plants. Not only should he recognize the plant, but he might well be familiar with measures for its eradication. Since more than a hundred other plants have been adjudged capable of producing dermatitis, the student should be aware of a number of them by name if not by sight. Field trips, mounted specimens, and visual aids serve this purpose admirably.

Many newspapers publish the daily pollen counts during the hayfever season. The pharmacognosy student would be remiss in not understanding the procedure involved in pollen counting and possibly in performing several pollen counts. The slides may be exposed at home by the student--he need not use the approved pollen exposure apparatus.[1] Standard microscope slides

[1] Described in The Journal of Allergy, 17, 178 (1946).

(75 x 25 mm.) are coated lightly with a petrolatum mixture (3 parts of white petrolatum to 1 part of liquid petrolatum), are labelled with the time, date,

and place, and then are exposed in a suitable location protected from the rain for a 24-hour period. For student purposes, a porch railing or window sill will suffice as an exposure place. Following the time interval the slide is ready to be examined. It may be stained immediately or it may be stored in a slide box until a more advantageous time. Several drops of Calberla's solution[2] are added to the slide, a cover glass 22 mm. square is affixed, and

[2] Formula: glycerin 5 cc., alcohol (95%) 10 cc., distilled water 15 cc., saturated aqueous solution of basic fuchsin sufficient to make the solution a light red in color.

the microscopical examination is begun. All of the pollen grains under the cover glass should be recorded, and the total number should be divided by the figure 4.84 (representing the area of the cover glass); the result is the average number of grains per square centimeter of slide surface. This figure indicates a total pollen count whereas a differential count reflects the identity as well as the number of each different type of grain.

A differential count requires either considerable experience on the part of the examiner or a set of check slides or reference drawings to insure exact identification. Check slides are made by collecting the pollinating flowers of trees, grasses, or weeds at the proper season and sprinkling the liberated pollen lightly over the surface of a coated slide. Such slides, when stained and covered, are useful for only a limited time. The glycerin jelly method of making permanent mounts[3] is quick and economical; the slides

[3] Wodehouse, R. P., Pollen Grains. New York: McGraw-Hill Book Company, Inc. 108 (1935).

may be stored for several years. Both of these methods demonstrate the pollens in their expanded, natural condition.

Mold spores are one of the chief allergens in non-seasonal hayfever and are found in the atmosphere throughout the entire year. They are smaller and more difficult to identify since they so closely resemble each other. Ordinarily, allergenic pollen grains range from about 16 to 45 microns in diameter; in comparison, many mold spores measure less than 5 microns. Exceptions to this rule are the spores of the mold Alternaria which are relatively large and, because of their unusual appearance, rather easily identified. It is more advantageous to determine molds in the atmosphere by exposing a bacteriological Petri dish, suitably prepared with a culture medium, for a ten-minute period in the same location as an exposed slide. The dish is then covered and incubated at room temperature. The resultant vegetative growths of the molds are often characteristic; after conidia have formed, the spores may be studied and compared. Since each individual mold colony is the resultant growth of one spore, counts may be easily calculated. In studying molds it is helpful to resort to a type culture collection for comparative purposes.

Other aerobiological matter may also be found on exposed atmospheric slides. Students' interest is heightened by finding microscopic ticks and mites, starch grains, plant hairs, parts of insects, and a miscellany of organic and inorganic matter.

The purpose of such a laboratory exercise is to afford the student first-hand information regarding the content of the atmosphere and to emphasize the tremendous possibilities for air-borne allergens contacting the nasal mucosa of the allergic individual. Pollen counts, insofar as the hayfever patient is concerned, have little or no practical value, either beneficially or detrimentally. By the time the patient reads the published pollen count in his daily newspaper, the 24-hour period has long since elapsed. Thus, except as a means of corroborating the severity of his previous day's symptoms, the patient is neither enlightened nor forewarned. The student, however, should realize that regional and national pollen counts are tremendously important in compiling data for all sections of the country. For instance, Seattle, Washington; San Francisco and Los Angeles, California; Key West and Miami Beach, Florida have a ragweed pollen index of less than 1.0. On the other hand, Des Moines, Iowa; Evansville, Indiana; Peoria and Decatur, Illinois; and Grand Rapids and Coldwater, Michigan have an index greater than 100. Daily pollen counts in the latter cities sometimes exceed 1000. The practicing pharmacist as well as the student pharmacist should be capable of advising allergic persons regarding vacation spots, and a possible choice of cities to establish homes in case the persons are considering a change of location.

To enhance the value of laboratory instruction, many display materials are available to the teacher. If the college of pharmacy or the pharmacognosy department maintains an herbarium, mounted specimens of allergenic plants can be exhibited during the class sessions. These could include poison ivy, poison sumac, and other members of the Anacardiaceae, and various members of the Euphorbiaceae to represent the contactants. Flowering specimens of elm, poplar, ash, and oak depict trees producing pollen antigens; timothy, orchard grass, Kentucky blue grass, and redtop represent pollinating grasses; and the ragweeds, plantain, a maranth, and lamb's quarter typify pollinating weeds. Vials containing the dried pollens and cultures of molds in Petri dishes are usually colorful and interesting. The various pharmaceutical manufacturers and specialty houses are co-operative in sending packages of allergenic extracts for display purposes. In addition to the customary pollen extracts and poison ivy extracts, there are many types of food extracts and contactant extracts. In the skin test packages for the scratch test the materials are sealed in capillary tubes, each allergen designated by a series of colors, a key being placed in the lid of the box cover. The colors are eye-catching and usually attract student attention and comment.

Other manufacturers will supply hypo-allergenic cosmetics, hypo-allergenic foods, and quantities of literature for distribution. Kodachrome slides of certain allergenic plants and their flowers are available commercially from biological supply houses, although photomicrographs of their pollens, of skin-testing techniques, of positive skin reactions, and other phases of allergy are not as yet on the market except through private individuals. Motion picture

films in sound and color are now accessible to the teacher. One of the latest and most thorough is a two-reel production entitled "Allergy--Immunology and Treatment" distributed at no rental cost other than transportation expenses through the Medical Film Guild, Ltd., 167 West 57th Street, New York, N. Y.

In summary I would like to state that the teacher of pharmacognosy has an excellent opportunity to add a subject of great practical value to his course material if he includes instruction in allergy and allergens. It has been my experience that student interest is keen throughout the presentation of this subject because of the personal experience he has had with one or another phase of it, be it his own susceptibility to poison ivy, his grandmother's hay-fever, his uncle's strawberry rash, his sister's cosmetic dermatitis, his pal's penicillin reaction, or if he works in a retail pharmacy, his customer's questions about anti-histamine drugs. Allergy today is a subject of tremendous popular appeal; it is caused by allergens of plant and animal origin, and thus is deserving of a place in the modern course in pharmacognosy.

Pesticides

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For many years some information concerning pesticides has been included in courses offered in colleges of pharmacy. The items considered, at one time, included mainly red squill and a few insecticidal materials of plant origin. Later some schools offered courses dealing with insecticides, rodenticides, and fungicides.

During the past twelve or thirteen years so many developments have taken place in the field of pest control materials that the opportunities for organizing a course and presenting the materials to pharmacy students have been greatly enhanced.

As the term is used today pesticides include insecticides, rodenticides, fungicides, and herbicides. Since the beginning of World War II many changes have taken place in the numbers and kinds of materials used for controlling pests, and changes are still taking place every day.

Some general recommendations concerning the organizing of such a course were made in an article by this author published on pages 49-54 of The American Journal of Pharmaceutical Education, volume xv, No. 1, January, 1951. These recommendations were concerned with the qualifications of the teacher; sources of information including textbooks, bulletins, and other publications; acquiring of display materials; course content; extent of the course; and certain other aspects.

Even though each teacher will handle the presentation of the subject matter in his own way there are aspects of the course that might be dealt with here and that teachers might find helpful.

A consideration of pest control materials themselves is not enough. Students must first learn something of the pests which are to be controlled. This means that some time must be spent by the teacher instructing students in the characteristics of insects, rodents, fungi, and weeds, as well as presenting other information about these pests.

When considering individual pesticidal materials it is suggested that the teacher stress at least the following points:

i. History of its use and development.
ii. Selected physical and chemical properties.
iii. Specific uses and method(s) of action.
iv. Forms and preparations marketed.
v. Their methods of use.
vi. Toxicity and nature of hazards.
vii. Precautions and treatment of poisoning.

Laboratory work should be included with the didactic.

Following are a few suggested laboratory topics:

i. Insect identification.
ii. Insecticide testing using living insects.
iii. The reactions of rodents to ingested poisons.
iv. The use of seed-treating chemicals in seed germination.
v. Study of diseased plant materials.
vi. Weed identification.
vii. Experimental spraying of weeds and other plants with herbicidal materials.
viii. Reaction of seeds and seedlings to herbicides in soil.
ix. Field trips during which a variety of materials should be discussed with the students.

In a subject where course content changes as rapidly as is the case here it is especially necessary for one to keep close watch of the literature. Students should also be impressed with the importance of this practice. In addition the teacher should stress the value of the retail pharmacist having a pesticide "library" available in the store. Selected textbooks plus a number of carefully selected state agricultural experiment station and United States government bulletins are essential.

It is well known that pesticidal products make excellent items for sale in the retail store. During the progress of the course the students should have ample opportunity to familiarize themselves with a variety of these products. This means the teacher must assemble a select group of items for this purpose. Manufacturers will be found to be very helpful in developing a collection of demonstration materials.

Students taking this course should have completed at least the prerequisite courses of botany, zoology, and organic chemistry. Without a background in these subjects the student will not be able to comprehend the subject matter of a course dealing with pesticides.

In bringing this talk to a close it seems appropriate to offer an opinion as to whether pesticides should be considered as a part of pharmacognosy or as a separate course. Perhaps at one time sufficient material could have been included as a part of the regular course. Such is no longer true. Time does not permit the presentation of a sufficient amount of information there. To present sufficient material concerning pesticides it should be offered as a separate course.

Reference

Maynard W. Quimby, A Course in Economic Biology for Pharmacy Students. The American Journal of Pharmaceutical Education, volume xv, No. 1; pp. 49-54; January, 1951.

Section F - CORRELATION of PHARMACOGNOSY INSTRUCTION and PHARMACOGNOSY at the GRADUATE LEVEL

The Correlation of Pharmacognosy and Dispensing Pharmacy

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The feature that distinguishes a professional curriculum from a liberal one is the more complete interdependence of the professional courses. In pharmacy, the correlation of course sequences is oriented along fairly straight lines, which project out of previous academic experience, through the present, and into the future, which intersect at many points and at multifarious angles, but which travel, in general, a common direction. Too many of us educators, from our status in the perpetual present, externalize our thinking only to deplore the devious guidance derived by our students from their prerequisite courses; too few of us project our thoughts toward reorientation of their views in the direction of future classes - hence the source of much interdepartmental discontent, and hence the need for more conscious efforts toward cooperative integration.

Dispensing pharmacy has been looked upon as the intersect toward which the curricular lines of precedent course work converge; this position has been justified by better minds and words than mine. Were this idea quite true, however enviable the situation of the teacher of dispensing pharmacy might then become would be a debatable question: unifying the vast quantity of information gleaned from a three or four year professional sequence would be an almost insuperable task. However, his load could be - and should be - considerably lightened with cooperation from the teachers of precursory subjects.

Very recently, Prof. Mitchell J. Stoklosa (1) offered a most interesting list of twelve crude drugs and twelve prescriptions with a citation for each drug-prescription combination of at least one "dispensing point." Emphasis was placed on the introduction of these points by the Department of Pharmacognosy at the time the drug in question was studied. (It is to be hoped that the Department of Pharmacy advanced this commendable plan farther when the students passed into its jurisdiction.) Prof. Stoklosa's suggestions were very specific; however, he sounded a more general thesis when he said,

> "Of greater significance to the teacher of dispensing and, therefore, of more value and interest to the student, are the important dispensing points involved in the compounding of prescriptions that contain preparations of plant drugs or their constituents."

The generalities that can be drawn during the course in pharmacognosy, then, as well as the specificities that can be cited, are of high order importance.

Integration of pharmacognosy with pharmacy courses does not necessarily have to be postponed to a junior or senior course in dispensing pharmacy. While its projection may be ultimately toward dispensing as the capstone course in the pharmacy sequence, its fundamentals are just as relative to earlier courses in pharmacy. When it is realized that these earlier courses

in the Department of Pharmacy are aimed even more directly toward dispensing, correlation at the lower level assumes greater importance, since it bears on two courses, the one directly, the other indirectly. At the University of Utah, for example, as the teacher of general pharmacy, I have tried to develop the beginning sequence so that, on its completion, the students should be able to approach any reasonable list of ingredients (e.g., an official formula) with some idea of how they can be put together to result in an acceptable product; the students, then, should enter upon their dispensing course to learn there how a list of ingredients (now, a prescription) must be put together to result in the most acceptable product. It is impossible to pursue this objective without bringing about interplay between the techniques of pharmacy and the fundamentals of pharmacognosy, particularly as that discipline is related to the extractive processes used for drugs. These processes, after all, are not decided upon in a haphazard, empirical manner; they are, instead, derived from the application of pharmaceutical principles to pharmacognostical details. In the presentation of the galenicals that are prepared by processes of extraction, I have found that there can be exercised a great deal of recall and correlation, in which phases my students' facility with pharmacognosy plays a leading role. But of more consequence is the projection of this information toward the future course in dispensing pharmacy which must lean heavily on relationships that have their roots in pharmacognosy.

A crude drug frequently constitutes the basis for an entire series of correlations that can be carried directly or indirectly into dispensing pharmacy. If the strength of the active constituents of the drug is known, there automatically follow the strength of the fluidextract and, less automatically, the strengths of the tincture and of the extract. The doses of the preparations of the crude drug, by and large, vary inversely with their strengths. Whether the plant constituents are alkaloids, glycosides, resins, tannins, or whatever determines the solvent used to extract them and the process of extraction to which they will be subjected. Thus, we have from one seemingly laboriously memorized set of data, the key to information for a system of preparations that are not infrequently found in dispensing questions of strength, dose, constituent-solvent problems, etc.

To detail an example, a table can be set up for the three closely associated drugs of the Solanaceae family, Belladonna Leaf, Stramonium, and Hyoscyamus:

	Belladonna Leaf	Stramonium	Hyoscyamus
CRUDE DRUG			
Alkaloid strength	0.35 %	0.25 %	0.040 %
Dose	--	--	0.2 Gm.
FLUIDEXTRACT			
Process	A (mod); E	A (mod)	A (mod)
Menstruum	3A / 1W	3A / 1W	3A / 1 W
Percent strength	100%	100%	100%
Alkaloid strength	270-330 mg. %	220-280 mg. %	35-45 mg. %
Dose	0.06 cc.	0.075 cc.	0.2 cc.
TINCTURE			
Process	P (mod.)	P (mod.)	P (mod.)
Menstruum	3A / 1W	3A / 1W	3A / 1W
Percent strength	10%	10%	10%
Alkaloid strength	27 - 33 mg. %	22 - 28 mg. %	3.4 - 4.6 mg. %
Dose	0.6 cc.	0.75 cc.	2 cc.
EXTRACT			
Process	" A (mod.)"	" A (mod.)"	" A (mod.)"
Menstruum	3A / 1W; A	3A / 1W; A	3A / 1W; A
Percent strength	400%	400%	400%
Alkaloid strength	1.5 - 1.35 %	0.9 - 1.10%	135 - 175 mg. %
Dose	15 mg.	20 mg.	50 mg.

These and similar correlations, introduced by the instructor in pharmacognosy, and demonstrated by the teacher of beginning pharmacy in his discussion of the groups of galenicals prepared by methods of extraction, constitute logical associations that will well serve the senior in his dispensing practice.

The definition of the action of drugs in terms of their active ingredients opens up other avenues of correlation between pharmacognosy and dispensing pharmacy, one of which can be found in the concept of imcompatibility. The presence of alkaloids in a drug or its preparations sets forth the possibilities of the general incompatibilities of that group; with general rules in mind, the students can more readily identify the exceptions as he meets them. The discussions of the solubilities of alkaloids and their salts, of incompatibilities and the simplest means of overcoming them are equally applicable to the course material in pharmacognosy and pharmacy. The glycosides constitute a second class whose hydrolysis can be encouraged or retarded, depending on the desired end, by controlling their pharmaceutical environment. That resins are most stable in alkaline solution is a fact applicable to the preparations of drugs containing resinous principles as well as to the precipitation of such constituents, when desired, by acid mediums. Tannins run a gamut of incompatibilities that require extensive consideration in the handling of products containing them.

In addition, instruction of the physical, chemical, and physiological natures

of the active constituents of the crude drugs, of the similarities traceable to identities in structure, and of the dissimilarities brought about by variations in structure is not alien to the subject matter of pharmacognosy. A brief account of the interdependence of structure and physiological activity in classic examples would orient the students' interests toward future courses both in pharmaceutical chemistry and pharmacology; the physical and chemical characteristics of the constituents, active and inactive, are of prime consideration in theoretical pharmacy. A discussion of the peculiarities of certain important constituents will go far toward explaining their deviations from the general rules that form the background for study in all of these areas. And eventually, the integration of this material through these various approaches culminates in dispensing pharmacy. This suggestion, of course, presupposes some prior contact with organic chemistry, general or pharmaceutical; however, with the trend toward a separation of the purely professional courses from the introductory ones, it is not at all unreasonable to propose that this sequence will some day be universal, where today it is only fairly common.

Finally, if we wish to - and it seems essential that we do - take a critical account of the dispensing habits of the post-graduation pharmacist, we cannot close our eyes to the results of the numerous recent prescription surveys: an ever increasing number (now greater than 90%) of medicinals are prescribed by their commercial names. This state of affairs points up the near necessity for teaching in our classrooms trade names for commercially available dose forms of all medications, including crude drugs and their active elements; the subject has been thoroughly exploited by Heber W. Youngken, Jr. (2) before a group similar to this one. Immediately there appears an excellent opportunity to familiarize the students with a practical terminology and, at the same time, to display the thriving significance of pharmacognosy as an area of pharmaceutical specialization. Inasmuch as the pharmacognosists lay claim to the drugs of animal as well as of vegetable origin, they add to their already broad repertory the very long list of industrially prepared serums, toxins, anti-toxins, and products of the endocrines. The demonstration of the great number of commercial items that are crude drugs themselves, that are products isolated from crude drugs, or that are products synthesized to duplicate those occurring in crude drugs certainly cannot help establishing among students of pharmacy, from their first introduction to the subject to the end of their academic training, a respect for pharmacognosy as a preëminent contributor to the armamentarium of the professional pharmacist.

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References

(1) Stoklosa, M. J., Contributions of the Teacher of Pharmacognosy to the Course in Dispensing, Am. Jour. Pharm. Ed. 15, 435 (1951).

(2) Youngken, H. W., Jr., What Emphasis Should Teachers of Pharmacognosy Place upon Prescription Specialties and Proprietaries? ibid. 16, 62 (1952).

Correlation of Pharmacognosy and Pharmacology

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Although pharmacognosy is one of the oldest of the time-honored pharmaceutical disciplines, teachers of this subject have been slow to recognize the change which has occurred in pharmaceutical education and in the historic functions of the pharmacist. As a result, pharmacognosy, as taught in some schools, has been left so far behind that some educators have questioned its position in the pharmaceutical curriculum, whereas others have suggested that this fundamental science be "patched up" with such odds and ends as insecticides, fungicides, herbicides and rodenticides. Still other educators have claimed that the basic defect in pharmacognosy resides in the classification employed by the instructor in presenting the course material. Some pharmacognosists favor a taxonomic classification; others prefer either a phytochemical or a physiological classification.

In the final analysis one must admit that this science, if revised to suit the needs of present-day pharmacy, has a definite and important position in pharmaceutical education. Although it must be granted that insecticides, fungicides, herbicides, and rodenticides may rightfully belong in pharmacognosy, there is already such an abundance of material in this subject that its proper organization and economic presentation offers a definite challenge to the teachers of this discipline. Moreover, if the instructor in pharmacognosy makes a serious effort to blend this subject into the overall training of the pharmacist, it makes little difference, in the writer's opinion, which classification is employed in presenting the material.

There are two major criteria which determine whether a course in pharmacognosy is a dynamic, useful, pharmaceutical discipline correlating well with pharmacology and other major divisions in the pharmacy curriculum or is a static course comprising a memorization of myriads of facts. The first factor involves the careful selection of the drugs and the second is concerned with emphasizing that material which has direct, prerequisite value for the subsequent course in pharmacology. It is the purpose of this paper to point out, from a pharmacologist's point of view, how these factors can bring about an effective correlation between pharmacognosy and pharmacology.

It should be obvious that the most prominent area for correlating the course in pharmacognosy and pharmacology is in the selection of the drugs to be studied. The course in pharmacognosy should include all drugs of plant and animal origin which have sufficient pharmaceutic or therapeutic demand to warrant their consideration. This list should be constantly revised by adding new council-accepted or specialty drugs which are of plant or animal source, or which contain active principles from such source. In order to keep the course in pharmacognosy dynamic and to correlate it with a well-organized course in pharmacology, the instructor should be just as alert to new drug developments as he is quick to recognize drugs which have outlived their therapeutic usefulness. Under no circumstance should he include drugs simply

because they were in the course when he took it or because the drug has appeared on some obsolete state board examination. In other words, the instructor in pharmacognosy must be a leader in his field of specialization and not a follower.

Emphasis is the second major criterion which determines how well pharmacognosy correlates with pharmacology. This factor is important from two points of view:

(1) The overall emphasis which is placed on drugs of the same therapeutic groups.

(2) The specific emphasis which is placed on the detailed information concerning the individual drugs.

To achieve maximum integration with pharmacology the instructor in pharmacognosy should emphasize only those drugs which have useful pharmaceutic or therapeutic applications. For example, when considering the subject of volatile oils, only historical attention, if any mention is made at all, should be paid to their action on the kidney, whereas their use as carminatives and flavoring agents should be emphasized. In a similar manner, only historic attention should be given to the diuretic properties of buchu, whereas the diuretic properties of the xanthine derivatives should be emphasized. There should be no time in a modern pharmacognosy course for teaching drug uses which are no longer valid. If due care is not exerted in this regard, there will be little correlation between pharmacognosy and pharmacology, and the student will come to question the validity of his work when such drugs as volatile oils and buchu are dwelt on at length in pharmacognosy and are not mentioned as diuretics in pharmacology. In fact, they are not even listed as such in several modern text books on pharmacology.

Some of the details of the individual drugs which should be emphasized include history, source, constituents, use, dose, and the names of available preparations. It is the prerogative of pharmacognosy--a science as old as pharmacy itself--to mention some of the details of habitat, collection, and preparation for market, and some of the fascinating stories associated with the development of drugs. When properly presented, such an approach not only creates interest on the part of the student, but also provides a background for subsequent work in pharmacology. Likewise, pharmacognosy should concern itself with the origin of useful drugs obtained from plants and animals. In the event the pharmacognosy instructor has specialized in the taxonomic approach to the subject, care must be exercised at this point lest he delve too deeply into the taxonomy of the drugs and neglect the opportunities to deal with the histology of the parent substance. For example, when discussing the source of preparations of the anterior pituitary, it should be pointed out that there are only three types of cells in this portion of the gland. Subsequent discussion could then center about the histological changes which occur when the gland secretes. Similar opportunities for considering the histology of the gland are available when discussing the active principles of the posterior pituitary, adrenals, liver, stomach, thyroid, pancreas, etc. In addition, some consideration should be given to the processes whereby living plant and animal

organisms synthesize complex organic compounds from less complex ones. Some understanding of biosynthesis and cellular histology will serve the student well in later courses dealing with the effect of drugs on cellular function. Perhaps the most important segment for correlating pharmacognosy and pharmacology is concerned with the composition and chemical nature of the active principles. At this point, attention should be directed to the physical and chemical properties of the active principle, the effect of optical isomerism on drug activity (epinephrine, hyoscyamine, and atropine, etc.) and the relationship between the active principles as obtained from two different plant sources. An unusual opportunity in connection with the last-named relationship is provided by the cardiac glycosides obtained from Digitalis purpurea and Digitalis lanata. In the example cited, it should be mentioned that each glycoside represents the combination of an aglycone or genin with one or more molecules of sugar and that the pharmacological activity resides in the aglycone or genin, whereas the particular sugar attached is thought to control water solubility, cell penetrability, and persistance of cardiac action. The relationship of the glycosides obtained from the two sources as shown by enzymanic and alkaline hydrolysis or by acid hydrolysis, could then be compared and contrasted. Such information is fundamental to pharmacognosy and provides a firm basis upon which the pharmacology of these glycosides can later be built by the pharmacologist.

Although there may be some teachers who object to including therapeutic uses in the basic pharmacognosy courses, I am sure this practice would not only create student interest in the various drugs, but would also tend to better correlate pharmacognosy with pharmacology. Furthermore, it is as much the right of the pharmacognosist to venture into the field of drug use, as it is the pharmacologist' s prerogative to venture into the field of therapeutics. Nevertheless, this privilege carries with it the obligation that the pharmacognosist be as critical in the uses he assigns to the various drugs as is his colleague in pharmacology.

A mastery of posology comes only with repetition. Therefore, it is the responsibility of pharmacognosy to insist that the student commit to memory the official dose of a carefully selected list of useful drugs. When possible, all courses in pharmacy should refer to the dose of the drug under consideration. Such repetition is important and will most certainly help the student retain this valuable information.

The tremendous increase in the multiplicity of trade names for various active principles has made it virtually impossible to cover them adequately during the usual courses in dispensing pharmacy, pharmaceutical chemistry, and pharmacology. Inclusion of the generic and trade names for crude drugs and their active principles in the course in pharmacognosy would not only provide an area of intimate correlation with pharmacology and other pharmaceutical disciplines, but would also direct student attention to the more practical aspects of pharmacognosy. Thus, the student would learn to associate with digitalis preparations such trade names as Digifolin, Digiglusin, Digitalone, Digitan, and Digitol; with digitoxin such trade names as Cardigen, Crystodigen, Digisidin, Digitaline Nativelle, Digithyl, Purodigen, and Unidigen; and with

lanatoside C the trade name of Cedilanid. This list is not complete but will serve to illustrate the importance of trade names in modern pharmacognosy.

Finally, it should be mentioned that it is too much to expect those instructors in pharmacognosy who have been trained primarily as botanists, without the benefit of some training in pharmacy or pharmacology, to correlate their subject with pharmacology. At the same time, one should not expect the ultimate degree of correlation between the two courses when the instructor in pharmacology has no firsthand knowledge of the scope of pharmacognosy. Therefore, the instructors charged with the responsibility of teaching these courses should be familiar with, or at least become familiar with, the aims and objectives of both disciplines.

In summary it may be stated that pharmacognosy, if kept up-to-date and presented in a modern form, is a fundamental discipline necessary for the successful training of the pharmacist. Although there may be advantages to one method of classifying the material presented in pharmacognosy over that of another, one classification can be just as deadening as another if care is not used in selecting the drugs to be considered and if the emphasis given various drugs is incorrectly placed. Attention has been directed to the fact that the careful selection of drugs and the proper emphasis provide the greatest areas for correlating pharmacognosy with pharmacology. Emphasis should be placed on those drugs of therapeutic or pharmaceutic merit and on certain details of the individual agents. Those details which should receive attention in order to achieve maximum correlation with pharmacology are as follows: history, source, composition, use, dose, and names of available preparations. The ultimate degree of correlation between these fundamental courses can be achieved only when the instructors concerned have an understanding of, and a sympathetic attitude toward, each other's subject.

Correlation of Pharmacognosy and Pharmaceutical Chemistry

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Dr. Edward Kremers used to say that "there are no hard and fast lines in nature". We might paraphrase this and state that there are no hard and fast lines in a pharmacy curriculum. Considerable overlapping of subject matter in pharmacognosy, pharmaceutical chemistry, pharmacy, and pharmacology is inevitable because of the interdependence of each on the other. Therefore, the problem of course correlation and integration is indeed important.

Because the boundary between pharmacognosy and pharmaceutical chemistry has become even more obscure with the more recent developments in the teaching philosophy of pharmacognosists, pharmacognosy has been charged, unjustly I think, with poaching. There are those, chiefly pharmaceutical chemists I'm afraid, who have voiced opinions to the effect that the so-called "new pharmacognosy" is trespassing on a domain which they have regarded as sacrosanct unto themselves. I do not believe that this is the case. The teacher of pharmacognosy cannot ignore the chemistry of plant constituents if his course is to have any meaning to the student. As a pharmaceutical chemist I feel that chemistry is so important that it cannot be ignored in any of the courses we offer in our pharmacy schools. It is basic and without it any of our pharmaceutical disciplines would be pretty shallow. I don't think I would even exempt pharmacy administration, although there is perhaps room for argument there.

Just because the pharmacognosist has to discuss some chemistry, however, does not mean that he is competing with the pharmaceutical chemist, nor is he trespassing on foreign territory. I think Prof. Edman of Stockholm has intelligently evaluated the situation when he reasons, " ....one can not say that pharmacognosy and chemical pharmacy compete with each other concerning the chemical nature of drugs. Of course, even chemical pharmacy had to be interested in the chemistry of drugs, but its occupation with this is essentially different from that of pharmacognosy. The chemical pharmacy treats the chemical nature of a constituent, its manner of reaction, synthesis as well as qualitative and quantitative determination: whereas, pharmacognosy works with the biological and biochemical relations of the constituent (formation within the organism) and role in its metabolism, relations dealing with preparation and storing of drugs, as well as with culture of drug plants and experimentally improving them, and also their pharmacodynamical significance." (1)

The chemist-critics probably feel that the courses which are being endangered by the newer philosophy of pharmacognosy are plant chemistry and those portions of organic medicinal products which are concerned with natural substances. There is no doubt that plant chemistry and pharmacognosy have much in common with the line of demarcation being hazy at best. Each is certainly concerned with the same things - the active constituents of plants, their biosynthesis, their chemical transformations, their inter-

relationships, etc. However, the approach and the emphasis are different. Since very few schools offer a separate undergraduate course in plant chemistry per se, I see no reason why the pharmacognosist should be criticized for introducing a considerable amount of chemistry into his course, the extent depending, obviously, upon his qualifications and interests. In fact, here is an excellent opportunity for cooperation and correlation of material between pharmaceutical chemistry and pharmacognosy.

We should not waste our time, however, trying to find subtle differences so that we may draw a "hard and fast line." Both groups might well take heed of the old saying, "If you can't beat 'em, join 'em." So let's get together and see how we can correlate our material even more.

The course commonly known as organic medicinal products or chemistry and pharmacy of medicinals usually follows or is taken concurrently with the basic course in pharmacognosy. In the latter case integration of course material is perhaps mechanically more difficult, but at the same time a concurrent offering of the two presents interesting possibilities. For example, the instructors have an opportunity to integrate their subject matter so that the class is studying the chemistry of a particular gfoup, say glycosides, at about the same time they are taking up the pharmacognosy of the glycoside-containing plants. I am quite aware of the practical difficulties which would confront those charged with the planning of such an integrated program and I can present no panacea. The closest cooperation between instructors, along with a great deal of patience, understanding, and broad-mindedness would be required. It would probably be impossible to work out a plan in which the material of the two courses dove-tails 100%, but with even a rather loose integration the advantages weigh heavily in favor of such an arrangement. Whether the pharmacognosy portion should preceded the chemistry portion is a moot question somewhat akin to the priority debate of chicken vs. egg. In practice it would probably vary, but correlation could still be attained through cooperative effort.

Since organic medicinals usually follows pharmacognosy, correlation of the two courses is largely the responsibility of the pharmaceutical chemist; however, a better correlation will result from consultation and planning with the teacher of pharmacognosy. The latter also should benefit from such consultation. I regard pharmacognosy almost as a prerequisite for a course in organic medicinal products and I imagine most of my pharmaceutical chemistry colleagues will concur. It is much easier to discuss the chemistry of the opium alkaloids, for example, with a class whose members know what opium is, where it is obtained, what alkaloids are associated in the crude drug and in what form they exist, what the problems of isolation are, and what the drug's uses are. With this class background, the teacher can begin his discussion by quizzing his students orally on these important points and by so doing can accomplish several objectives.

First of all, the student benefits from a review of his pharmacognosy. Information is remembered when it is frequently used. Secondly, the student develops a greater appreciation of what he has learned as he sees it applied. Certainly the pharmaceutical chemistry instructor has a wonderful opportunity

to emphasize the applications of pharmacognosy when he discusses the chemistry of natural products. If he doesn't, he cheats the student. Thirdly, by increasing class participation in his presentation, the instructor can stimulate his students and increase their interest. Fourthly, through such a review (and it need not be long), the teacher introduces and lays a foundation for his discussion of the structural features of the compounds under consideration, their physical and chemical properties, incompatibilities, reasons underlying special storage methods, and structure-activity relationships. Emphasis and re-emphasis on nomenclature is also accomplished -- an important consideration which is often neglected.

The prerequisite value of pharmacognosy to organic medicinal products is further illustrated by the fact that the rather general picture of alkaloids which the student gains in his course in pharmacognosy prepares him for the more detailed discussion of their chemistry. Similarly, the student who is familiar with digitalis, strophanthus, and squill is much better equipped to absorb the chemistry of the cardiac glycosides and certainly will better appreciate it. Here and with all the other classes of compounds he will find the comparison between natural products and their synthetic variants more meaningful and interesting. With a firm pharmacognosy foundation in his students' background, the teacher of organic medicinal products can compare natural and synthetic compounds pointing out the advantages, if any, of one over the other. Knowledge of natural products can serve as a starting point for the suggestion of new synthetic congeners. Here the instructor has an opportunity to build a lasting impression of the truth that natural and synthetic drugs are not in competition, but rather that they supplement and complement one another.

Speaking of the student's general pharmacognosy training, it seems to me that pharmacognosy teachers should be urged to place great emphasis on those crude drugs whose active constituents are fairly well known. These drugs are those with some rational reason for clinical usage. At the same time, the pharmacognosist, the pharmaceutical chemist, and the pharmacologist share jointly the responsibility for learning more about the nature, constitution, and efficacy of some of the older drugs. If no value can be discovered, all concerned should plead for their discard.

A high degree of correlation and integration between pharmaceutical chemistry and pharmacognosy is also possible in the area of antibiotics, vitamins, and hormones. The method of presentation of these important groups of medicinal substances varies in our schools of pharmacy. Many schools have created separate courses whereas others include them in appropriate existing courses. My own experience in organic medicinal products is that I have never had enough time to give adequate coverage to them. My pharmacognosy colleagues have likewise expressed themselves as not having sufficient time. Therefore, a separate course, often combined with biological products, seems to be an answer to the problem. Certainly the importance of antibiotics, vitamins, and hormones in modern prescription practice justifies such an arrangement. The American Druggist fortnightly prescription survey in the first six months of 1953 shows that antibiotics have ranked consistently either first or second in frequency of prescription; vitamins have

been third, fourth, or fifth; and hormones have been fourth, sixth, or seventh.

Here is an opportunity for real cooperation between the pharmaceutical disciplines. An integrated course with each expert presenting his own phase of the subject would most certainly provide the student with a complete picture of the field. If we restrict our discussion here to the role which pharmacognosy and pharmaceutical chemistry would take in such a course, the teacher of the former would discuss the biological aspects of each class and the latter would cover the chemistry and its implications. Thus instead of a specialist in one field attempting to teach aspects with which he is less familiar in addition to those in which he is expert, the class benefits by having all phases of the course taught by experts.

The course in pesticides also provides fertile ground for cooperation and correlation. In this case the initiative would probably rest with the pharmacognosist who is teaching the course, since it would ordinarily follow organic medicinal products where the chemistry of most of the organic pesticidal compounds would have been covered. By applying the chemical knowledge he has gained, the student develops a greater appreciation of the biological and commercial aspects of pesticides. The teacher can use the quiz-review technique described earlier to good advantage. If pesticides and organic medicinal products are given during the same year, a cooperative course similar to that described for antibiotics, vitamins, and hormones might profitably be employed. The pharmacognosist would present the biological and other non-chemical phases of the subject while the pharmaceutical chemist would discuss the chemistry. The material ordinarily presented on organic pesticides in the organic medicinal products course could then be transferred to the course in pesticides with salubrious effect on both.

Although pharmacognosy depends on drug assay for the determination of purity rubrics, the correlation between the two is pretty much a one-way proposition in that drug assay depends rather heavily on pharmacognosy in the field of analysis of crude drugs and crude drug products. For example, an ash or moisture determination would be meaningless routine to the student without knowledge of the properties of the drug such as cellular structure, part used, nature of active ingredient, etc. The course in drug assay should teach more than technique alone. With a background of information gained in pharmacognosy, the reasons for the various steps of analytical procedures come alive and take on added significance. The understanding of the determination of extractive and crude fiber content likewise depends on the student's knowledge of pharmacognosy. The determination of fat and oil content and their constants may also be correlated with information gained in pharmacognosy and elsewhere.

The student has learned the purity rubrics of important drug plants and in drug assay he is accorded the opportunity to check for himself the actual values. In dealing with volatile oils and their sources, for example, the nature of drugs such as chenopodium or clove or peppermint and the oils obtained from them naturally become better fixed in mind with the correlation of analytical procedures and chemistry with the information gained in pharmacognosy.

Perhaps the most striking example of correlation between the two courses will be found in the assay of alkaloids. As in other assays the student, in addition to the actual mastery of techniques, must learn the reasons for the various procedural steps. For example, why do samples vary in alkaloidal content? The student has previously learned the factors causing variation in his pharmacognosy. What complications are introduced by other constituents in the drug? The student should have learned what these constituents are in pharmacognosy. Certainly the understanding of drugs such as opium, cinchona, belladonna, etc., is made complete by the tying together of information gained in the two courses.

I have confined my remarks thus far to organic pharmaceutical chemistry because of the preponderance of natural products of organic nature. However, I would be remiss if I did not say something about correlation of pharmacognosy and inorganic pharmaceutical chemistry. The major area of application of knowledge of inorganic chemicals would be the course in pesticides. Such substances as arsenic compounds, fluorides, sulfur, sulfides, etc. are of commercial importance as insecticides. HCH, arsenic, phosphorus, fluorides, and thallium salts are widely used as rodenticides. Copper salts, sulfur, and mercury compounds find application as fungicides. Thus a working knowledge of nomenclature, physical and chemical properties, incompatibilities, etc. which the student gains in the course in inorganic pharmaceutical chemistry may be recalled and put to practical application by the pharmacognosy teacher.

An attempt has been made in this paper to present a few ideas of the ways in which pharmacognosy and pharmaceutical chemistry may be correlated. I have said nothing about the correlation between the two fields as it applies in graduate study since I felt that this would be brought out in the papers to follow. I hope that my remarks have stimulated or recalled other ideas in the minds of my listeners and that the discussion period will turn up more and better ways in which cooperation between the two areas may be furthered. As a teacher of pharmaceutical chemistry, I am firmly convinced of the value of pharmacognosy to my courses and that any effort spent in relating it to my own subject matter is well worth while.

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The Future Began Yesterday

W. Paul Briggs
American Foundation for Pharmaceutical Education

In these times, when good news is only news not quite as bad as we expected, it is stimulating and refreshing to live awhile in the serenity of science, isolated from the tip-toe land of fragile politics. Pharmacognosy is a strong and solid discipline, that literally has deep tap roots in the past, but strong branches reaching into many areas of therapeutic development of the future. These teachers' seminars provide unmatched opportunity for pruning, cultivating and harvesting in the lush field of knowledge.

I am especially grateful for the privilege of addressing this joint meeting of the Teachers' Seminar on Pharmacognosy and the Plant Science Seminary, because of the beloved Dr. E. L. Newcomb's deep interest and leadership in both groups. I know that he was missed during your sessions. I also know, that despite his diversified interests, he never gave up his first love for the science of pharmacognosy, or the Plant Science Seminar, of which he was the principal founder.

To perpetuate his memory and to encourage study in your field and his, the American Foundation for Pharmaceutical Education, last year, established three annual cash prizes of $250 each, known as the E. L. Newcomb Memorial Awards in Pharmacognosy. One of these awards may be made annually, in each of three groups, on a selective basis, from original essays or published papers submitted in competition by (1) undergraduate students; (2) graduate students and (3) teachers, researchers and industrial scientists. This year, awards were made only in the second and third groups.

The 1953 graduate students E. L. Newcomb Memorial Award went to Miss Elena Gautier-Auxence, now Instructor at the University of Chile, Santiago, for her illustrated essay on "PISCIDIA ERYTHRINA," completed while a student at the Massachusetts College of Pharmacy. The 1953 Award in the Teachers' group will be presented during pharmacys' meetings here in Salt Lake City to Drs. D. P. N. Tsao of Oregon State College, School of Pharmacy and Heber W. Youngken, Jr., of the University of Washington, College of Pharmacy, for their report on the investigation of "THE EFFECTS OF COBALT, ACETATES, ASCORBIC ACID, and CHOLESTEROL ON GROWTH AND GLYCOSIDE BIOSYNTHESIS IN DIGITALIS PURPUREA."

It is our hope that these first Awards, jointly honoring the recipients and the memory of Dr. Newcomb, will mark the beginning of accelerated research in pharmacognosy. We invite all interested in this field to submit papers to the Committee through Dr. Heber W. Youngken, Chairman, Massachusetts College of Pharmacy, Longwood Avenue, Boston 15, Mass. The other members of the Committee are Dr. George M. Hocking, Chairman, Subcommittee on Pharmacognosy of the Committee on National Formulary; and Dr. John E. Seybert, Pharmacognosist, Eli Lilly and Company.

The Committee has prescribed the following rules and procedure governing this competition, which are included here to make them available in the records of this meeting.

" Papers submitted in competition for an award must be principally in the field of morphologic, taxonomic or cytogenetic pharmacognosy, or in drug plant cultivation or commercial pharmacognosy. Phytochemical aspects of the work may be included in conjunction with one or more of the previously mentioned fields. Papers submitted for consideration must contain some new information ascertained from studies made by the contestant on (1) one or more medicinal, pesticidal, allergenic, poisonous or aromatic plants, or (2) one or more cellular drugs or pesticides or adulterants or substitutes thereof, or (3) methods of quantitative microscopical analysis as applied to the determination of the percentage of an adulterant in a natural cellular drug, condiment or pesticide, or (4) the cytology or genetics of a medicinal plant, or (5) the cultivation of one or more drug plants.

Unpublished essays must be typed double space on bond paper with from 1 in. to 1.5 in. margins and submitted in triplicate. Published papers may be submitted in the same form or as reprints, but must represent work which has been published not more than a year prior to its receipt by the Awards Committee. These also must be submitted in triplicate. All entries must be received by the Chairman of the Awards Committee by November 1 of each year. The winners will be announced and the awards made at an appropriate time and place.

Winning papers, published subsequent to receiving an award, should be identified by an acknowledgment paragraph or by a footnote indicating that it is an " E. L. Newcomb Memorial Award Essay. "

One of my many deficiencies results from the kind of training I received in pharmacognosy, which the A. A. C. P. Committee on Curriculum describes in their Report as " . . . the older concept. . . ' the science of crude drugs. ' " This is one reason why I say the future began yesterday. Thus I would be on very dangerous ground if I attempted to discuss the modern science of pharmacognosy -- and I have no intention of doing so. But in their Report I noted several references to this field that, inescapably, are of mutual concern to you and to the American Foundation for Pharmaceutical Education.

The following quotations from that Report are, of necessity, out of context, but solely for the purpose of brevity in reviewing the problem, not for mischief. The Committee says, " The subject of pharmacognosy as taught in many schools of pharmacy is in need of drastic revision. " It quotes Dr. Deno as reporting in 1951 that " In about a third of the colleges the instruction on the subject was judged to be inferior. " Again, the Report states " In some institutions the time devoted to it (pharmacognosy) is out of all proportion to the value of the subject in relation to other subjects of the curriculum. " And finally " The subject of pharmacognosy needs modernization and revision of its content. " Elsewhere, the Report dis-

cusses the importance of pharmacognosy and gives outlines for sound courses based on both biochemical and physiological classifications. It now would be quite in order for you to ask why I have quoted portions of the Report of the Committee on Curriculum that reflect somewhat unfavorably upon the present course content, and some of the teaching in pharmacognosy; a truly basic and exclusively pharmaceutical subject. I assure you that I have not done this to be unkind or to abuse your courtesy in permitting me to be with you.

I have reminded you of some of your own problems only in a spirit of helpfulness and to emphasize the interest of the Foundation in helping you to solve them. The support of the American Foundation for Pharmaceutical Education, which made possible this and the four preceding Teachers' Seminars, is evidence of our readiness to help, in any way possible, the further advancement of pharmaceutical education. The Curriculum Committee study was, as you probably know, supported by the Foundation, through The Pharmaceutical Survey. The Foundation has awarded 18 graduate Fellowships for study in pharmacognosy. These steps, and the previously mentioned E. L. Newcomb Memorial Awards, are collectively designed to strengthen teaching in pharmacognosy and pharmaceutical education in general.

I vigorously deny possession of any qualifications entitling me to evaluate the vast domain of pharmacognosy. However, I am impressed by the pharmacognosy section of the Report, prepared with the assistance of such professionally distinguished pharmacognosists as J. Hampton Hoch, Arthur E. Schwarting, Ralph F. Voight, Heber W. Youngken, Jr., and Robertson Pratt, that seemingly recognizes the urgent need for housecleaning and housebuilding in your field. We sincerely hope that this meeting has enabled you to refurbish the superstructure and strengthen the foundation of pharmacognosy.

Of the four critical quotations given earlier, only the shortage of professionally qualified teachers would appear to involve any lengthy period for correction. Even the supply of professionally qualified teachers of pharmacognosy should now be approaching the need through the past and continuing Fellowships in this field made possible by the Foundation. Thus, your future did begin yesterday -- with the constructive recommendations of the Curriculum Committee, with substantial assistance and encouragement from the Foundation, and your own progressive and realistic planning to revitalize training in the basic science of pharmacognosy.

Perhaps I have been rather presumptuous in reminding you of these comments of the Committee on Curriculum. I have risked your good will in an effort to serve you and pharmacognosy as a deeply interested, objective observer. Because it seems to me that whenever, and wherever, I hear pharmaceutical education discussed, by experts or by rank amateurs, pharmacognosy receives a "heavy play," and often, with "loaded dice." In my view, the future of pharmacognosy is in your hands -- teachers are always the link between the power and the problem. Speaking as the rankest kind of amateur, not even as a self-designated expert, it would appear that you could make a significant contribution to our educational program, and

your own speciality, by resolving the issues pointed up by the Curriculum Committee. Specifically, by promptly implementing the recommendations of this Committee by redefining the science of pharmacognosy; by adjusting the undergraduate training time requirements; by inspiring promising men to pursue careers in this field; and by modernizing the course content, you can catch up with your future, which really began yesterday.

I know that you will forgive me if I have unwisely tread upon sacred soil or innocently ventured into controversial fields. I am aware that each of you recognizes the critically urgent readjustments needed in the courses of the pharmaceutical curriculum. I hope that this fortunate and timely gathering, will provide the foreign particle so often helpful in starting the phenomenon of crystallization -- crystallization of plans for better teaching in the science of pharmacognosy.

The Objectives and Scope of Graduate Study in Pharmacognosy

H. W. Youngken, Jr.
University of Washington

The objectives and scope of any modern applied science are not easy to define without incorporating into them several objectives common to other sciences, pure and basic. Thus, Dr. George D. Beal(1) on the occasion of his recent dedication address at the University of Texas expressed it aptly when he stated, "It is difficult to talk about pharmacy's accomplishments as a science, when it is the practical application of a number of sciences. It is difficult to define any of these contributing sciences with precision because of their extensive overlapping. There is no longer any hard and fast separation of sciences into specific areas, or any rigid distinction between pure and applied science except perhaps in the mind of the individual scientist." Perhaps one of the many reasons for the rapid narrowing of the gap between the applied and the fundamental science has been the effort of the "applied" scientist to follow the method of the "pure" scientist to burrow more thoroughly into the "how and why" of things. This has then led him extensively into the fields of mathematics, chemistry, physics, and biology. It is difficult for one to imagine any area of pharmaceutical graduate research which does not have to dig deeply into these basic sciences at one time or another.

If we accept this premise, and I believe it is in keeping with all scientific areas regardless of how one attempts to define them, we then ask ourselves: what is the need for our departments of specialization? Why even try to establish certain areas for specialization in graduate instruction? If so, what are the objectives in research that are sought by a specialized area such as pharmacognosy?

I believe we will agree that a departmentalization of sciences is a convenient method for organizing science in general and certain specific scientific interests in particular. Persons with special and common interests work closer together when similarly identified. A kind of scientific fraternity exists as a result of an intercommunication of thought which may pivet about a precise scientific orbit. This thought and much scientific data can then be better coordinated and funneled into the most appropriate stream of knowledge for application to society. The data is more reliable if subjected to the criticisms of scholars with closely interwoven interests and specialized backgrounds. Students who seek advanced knowledge in science seek it through the major area of the graduate school in which their interest is best organized, where the specialists are located and in which facilities are inducive for research. It is from the doors of special interests in science that new knowledge passes into the broad streams of all knowledge.

Let us now look at pharmacognosy to determine, if possible, what objectives are especially peculiar to the graduate teaching in this science as a sphere for graduate study and research. In other words, what are its special interests? The best source for a composite review of the thinking among American pharmacognosists can be obtained from the several volumes of the American Journal of Pharmaceutical Education (see the Cumulative Index (2) and the subsequent volumes since 1949). The subject matter for research as published by several

American and foreign pharmacognosists is likewise to be found in the scientific literature, and although not voluminous, it has in most cases been significant. Among recent reviews covering examples of currently published research by pharmacognosists, none however complete, are those by Trease, (3) and Fairbairn, (4) and Youngken. (5) The published textbooks in pharmacognosy include additional references, which if compiled would swell the number to more representative quantities. Unfortunately published research among pharmacognosists in this country is not extensive in terms of the number of persons in the field who should be contributing. The troublesome fact is that although pharmacognosists in America have long claimed the products, structures, and certain phenomena of nature to be chief interests relatively few of them have reported the results of scientific investigations in the subject. Indeed, much of this has been left to workers in allied fields who righteously have common interests in much that we as pharmacognosists would also call germane to our special interest.

In being consistent with our original statements that there should be no boundaries beyond which research should fear to tread, likewise, there should be no concept that special interests in pharmacognosy are in themselves narrow. We can, however, say that among most characteristic interests wherein pharmacognosy graduate teaching and research have found fruitful endeavor have been those which seek a knowledge of the intracasies of the cell as a chemical factory, those dealing with the biological sources of new drugs, and those which seek improved methods or data for evaluating these or certain related subjects of investigation. These interests may be termed broad objectives of pharmacognosy research. They imply a wide range of endeavor with perhaps two outstanding searches in common; these are: 1. a better knowledge of the mysteries of nature as a producer of drugs, and 2. better methods for evaluating and interpreting that knowledge. Some would associate descriptive natural history, animal and plant physiology and biochemistry, with the first search; some might well associate chemical, physical, and biological analyses and applications with the second search. Such interpretations are proper. These rather broad special interests might then be broken down into certain narrower orbits of research. Eventually one then progresses closer to that part of the research spectrum which we shall call the basic science range. In so doing the inquisitive thinker might at times digress somewhat afield from his original objective. For surely, keen imagination in research often takes a worker into fields akin to his original interests. For example, how enticing it frequently is for one who seeks to search for the mysteries of drug alkaloid or glycoside formation in plants to delve into the fundamentals of cellular respiration, nitrogen and/or carbohydrate metabolism; or for the researcher who seeks descriptive knowledge of tissue structures to look into the phylogeny of tracheae among certain cryptogams or phanerogams; or for the student of antibiotics to seek the biochemical secrets of their mechanism of action; or for the pollen specialist to look at protein chemistry and the theories of Pauling; or for the pesticide specialist to study insect physiology; or for the virus specialist to study the techniques of three dimensional electron microscopy. Therefore any special interest having merit has broad concepts which intermingle with those of other sciences and the dynamic researcher will often not be limited in his search for knowledge to either the applied or basic side of the investigation. He will use both.

The graduate program in pharmacognosy in order to follow the above concepts must therefore be flexible, it must foster imagination and creativeness, and it must provide the student with as much intercourse with the allied basic and applied science as will best assist its objectives. But in specifying this and that subject as mandatory for the fulfillment of degree requirements a director must act with much caution 'lest he burden the student with a hodge-podge of improperly related scientific subject matter. The objective in planning the student's course program should emphasize as much as is possible those related basic science graduate courses which can be closely correlated with the applied. If a graduate student shows outstanding interest in morphology and structural cell relationships before he engages in advanced pharmacognosy courses which deal heavily with this subject, he should complete a basic sequence at the graduate level in plant taxonomy, morphology, anatomy, physiology, and cytology. If a student shows more interest in chemical and physiological aspects of pharmacognosy his basic graduate program should include among other courses, physical chemistry, biochemistry, cellular physiology, plant physiology, and/or genetics. Common to both lines of progress should, I believe, be graduate pharmacology advanced organic chemistry such as organic medicinal products and a course in biological statistics. The latter might be regarded to be important allied applied courses. The use of any of these courses depends upon the direction toward which aspect of graduate pharmacognosy is to be followed. A man cannot be expected to engage all of these basic sciences; nor is it necessary for him to do so to do creditable research. There are obviously other basic science courses from which to plan the interrelated program and some of these are as important as those previously mentioned; for example, microbiology and animal physiology. The graduate pharmacognosy program should then have as one of its objectives the placing of students in an organized related series of basic science courses. But I do not believe that courses should be set up simply to construct an impressive number of required entities in a graduate school program.

A second objective would be for the student to engage in non-thesis research problems as early as his background will permit. It is largely through his efforts in the research laboratory that he will learn the scientific method and seek to exploit the imaginations and interests which are his own. These objectives of the student are, after all, very important and he should possess every freedom to exercise them. His objectives are to apply the basic concepts learned and, with a minimum of applied factual data, to exercise keen observation in these; from these observations there will then develop imagination and a creativeness toward the investigation of a problem. Progress is made in the laboratory, not the lecture hall. I attach great significance to student activities early in the research laboratory program following completion of as many advanced basic science courses, particularly those dealing with some degree of instrumentation, as is possible within the details of a University course schedule. I do not believe that the objective should be for students to finish a great number of required applied courses, especially those which deal essentially with factual information, before progressing with a research problem in the pharmacognosy laboratory. The graduate objective should de- emphasize the factual type of catalogue learning. It should emphasize the experimental or scientific method. Just as the medical surgeon learns best by getting his fingers into the patient's

gut, or the dental surgeon who gets his fingers into the patient's mouth, so should the graduate student learn early in his career by getting his fingers to the test tube, Waring blender, microtome, or chromatography column. The laboratory is the place for this!

It is not the purpose of this discussion to deal further with the basic supportive courses referred to for completing the objectives of graduate instruction in pharmacognosy. Dr. Pratt will follow with that treatise.

Next we should examine briefly the scope of subject matter identified as graduate pharmacognosy courses. Among examples of courses listed in University or college graduate bulletins one will find advanced microscopy, including histo-chemistry, pharmacognosy techniques, economic biology, drug plant cultivation, medicinal plants, plant chemistry, drug plant biogenesis, hormones, antibiotics, allergens, pesticides, and others. These deal with highly specialized interests. To be worthy of graduate standing such courses cannot be superficial. Some, for example, hormones, antibiotics, phases of economic biology, and courses in pesticides may also be subjects of other university departments. Most are factual and unless emphasis is placed upon phases of experimentation and literature search in each, the subject matter can be nothing more than extended undergraduate course in facts. Therefore great care should be exercised in the organization and use of these on the graduate level. They have merit, it is true, if they can stimulate student thinking along experimental lines and if they are well supported by good literature readings.

Graduate course studies and research are generally supplemented by graduate seminar and conference activities. A fine objective is served by these and they should be either the general seminar type (9) or the departmental seminar. The purpose of graduate seminars can be expressed without qualification as " . . . one of the most effective learning procedures in graduate education," for indeed learning by frequent discussion and/or debate on issues of research not only stimulates thinking but also provides an informal outlet for expression. From oral expression there then comes confidence in one's approach. It is an important fact that as students progress their confidence in themselves should also be encouraged. Also included with the objectives of the graduate pharmacognosy or general seminar should be the effort to encourage students to participate in seminars of allied fields in the university. Obviously time is limited and at most the average graduate student can select only one or two ancillary seminars; but of these, those in botany, biochemistry and pharmacology often prove most fruitful.

A graduate course in pharmacognosy should seek to familiarize the student with the literature pertinent to its special interests. It is common knowledge that the problems of research are dependent upon the literature for it is through the thorough literature search that the strategy of an attack on a problem begins. A selective reference guide listing literature sources often employed for pharmacognosy and related areas has been prepared by Stuhr (6) and the techniques of library searching described by Alexander. (7) The several A. A. C. P. library reports by Lee (8) are extremely useful in cataloguing library information pertinent to pharmacognosy and related subjects.

English and foreign language journals should be frequently consulted by graduate students. It is along this line that the foreign language study in a graduate program can be well implemented. For, indeed, literature search and foreign language study go hand in hand. Not only is the scientific method exhibited by such literature, but often between the lines are reflected customs of a foreign society. The judicious practice with both literature and language is an important objective for the graduate program. It is through such communication channels that a student also gains much experience in the organizing and writing of his or her experimental report.

To summarize then, it becomes more obvious everyday that the boundaries of graduate instruction in pharmacognosy cannot be sharply drawn. In a broad sense the science of today deals with many concepts relating to an exploration of nature as a source of knowledge for composite and/or highly purified drug principles. Descriptive research mingles with the experimental, and the basic science with the applied. The chief objectives of a program of studies in this field are then to provide the maturing and inquisitive mind with sufficient background for an independent approach to teaching and research.

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Some Comments on the Use of Elective Courses in the Graduate Program in Pharmacognosy

Robertson Pratt
University of California

I have been asked to discuss "Effective Use of Elective Graduate Courses in Pharmacognosy." However, with your permission, I should like to change the title slightly and to consider "Effective Use of Elective Courses in Graduate Training in Pharmacognosy." The distinction and the reason for it will become apparent as we proceed.

Currently we do not offer a graduate degree in pharmacognosy at the University of California. This, of course, means that in one sense I speak without full experience of the problems that may arise. On the other hand, perhaps it makes it easier for me to be completely objective, since my thinking on the subject is neither conditioned nor set in a rigid pattern by ideas developed through long association with an already established program.

I should like to discuss three points, namely,
(1) General education for graduate students
(2) Communication (or more simply, English)
(3) Elective courses in the sciences for graduate students in pharmacognosy.

The first two topics, being more general, can be discussed more easily. The third topic is more difficult to discuss in general terms because, as I see the problem, the requirements and needs to be met vary from one student to the next, depending on previous academic experience, objective in pursuing graduate training, thesis research, and other personal factors. No general formula that will be satisfactory for all students can be prescribed for any of the above topics but at least a reasonable approximation can be made for general education and for communication.

It may be appropriate to consider for a moment our prospective graduate student in pharmacognosy at the time he receives the baccalaureate degree. When students graduate from our colleges and schools of pharmacy, they are well trained in the scientific and technical and theoretical aspects of pharmacy. Most of them also have acquired some practical experience to complement their formal academic training. Some of them even have acquired an education along the way.

I do not mean the last remark to be in any way disparaging to the graduates of our schools and colleges of pharmacy. However, in a program so tightly scheduled as the 4-year pharmacy curriculum there is little time to include work in the broader fields of knowledge and thought. One of the glaring deficiencies of education in all of the health sciences today is the neglect of the broader aspects of life and of our civilization. This defect results in our sending out with our blessings each year from schools and colleges of pharmacy many graduates who are little more than skilled technicians. They have a university or college degree but so far as knowledge of, or all too frequently even

interest in, the broad world of social, political, and cultural problems is concerned often they might just as well have graduated from a trade school.

There are at least two important adverse effects of this situation. First, it is bad for the prestige of the profession of pharmacy. Second, from the more limited, but perhaps ultimately more important point of view of the individual, lack of at least an introduction to the significant aspects of past and contemporary thought in other areas of learning, may make it difficult for the individual to achieve the fullest and richest life possible. This may seriously affect the life and mental health of a man or woman. For the average person this may be merely slightly serious. For the graduate student in pharmacognosy, most of whom presumably will enter the teaching profession, it may well be tragic. Certainly it is imperative, in order to properly fulfill his obligation to the community, to the student and his profession, no matter what his specialty may be, that a teacher, especially at the University level, be versed in the broader aspects of the humanities and social sciences as well as in the intricacies of his particular field of physical or biologic science.

A requirement for a year, or preferably two years, of preprofessional collegiate work, largely in the humanities or related subjects, would help to ameliorate this situation. Such a requirement might suffice for the student who plans not to continue in graduate studies and would, in time, help immeasurably to increase the stature of pharmacy in the opinions of the public and of the members of our sister health professions. But the teacher or the advanced professional worker should have a broader view and a deeper insight into human affairs than can be gleaned from a smattering of two or three lower division courses, especially when those are followed by the four years of intensive unrelated study of the pharmacy curriculum. The seeds planted in these preprofessional years should be watered, allowed to germinate and grow, and be brought into flower during the graduate years. To me, it seems important that the graduate student in any of the biologic sciences should be encouraged, or perhaps even required to select at least some of his elective courses from the offerings of departments of history, philosophy, economics, political science, or other groups of the social sciences. This is important if we expect our Ph. D. degree to mean more than a mere certificate for completion of an intricate technical program. We cannot expect all our Ph. D. candidates to be scholars, but we can, and should, expect them to have appreciation and understanding of world problems and of contemporary civilization. This is, of course, particularly appropriate in a field such as pharmacognosy which perhaps more than, and certainly as much as, any other field of science has been associated with the economic and political history of the world and even today has important economic aspects.

Now I should like to comment briefly on the second point, namely, communication, or English. I would include literature and English in the required elective group, at least for many students. Communication is a foundation stone in the structure of civilization and contemporary society. No one, least of all, a professional man or woman, can achieve full effectiveness if his ability to communicate ideas is not well developed. An old adage proclaims that "clothes make the man." If this is true, as unfortunately,

sometimes seems to be the case, it is equally true that language--the raiment in which our ideas are clothed--often may make an idea. The difference between acceptance and rejection of an idea often depends as much on clear expression of the idea so that all can understand it as on any other factor. Effective teaching demands ability of the teacher to express his thoughts clearly.

There is another aspect--a more personal aspect--to the question of language, both written and spoken. I have said language is the raiment of our ideas and thoughts. None of us would appear, nor would we like our protégés to appear, in public in spotted or dirty or inappropriate clothes. We should not be any less particular about the words in which we clothe our thoughts.

Possibly I have dwelt too long on these points. However, I think they are as important as any other aspects of graduate training.

Now, let us turn for a moment to the third topic, Elective Courses in the Sciences for Graduate Students in Pharmacognosy. Frankly, I am at a loss for specific comments on this subject, except for one remark, namely, that it appears to me that it is in this area that the advisor or counsellor meets his greatest challenge. Pharmacognosy cuts across so many areas of study that the kinds of courses that might be useful in graduate training are almost limitless. Advanced courses in physical chemistry, organic analysis, microchemistry, plant metabolism, bacterial metabolism, enzyme chemistry, endocrinology, physiology, biochemistry, genetics, soil science, ecology, plant morphology, entomology, and insect physiology, to say nothing of mathematics, statistics, physics, and a host of other subjects all may be used effectively in the training of graduate students in pharmacognosy. Which courses can be used most effectively to round out the student's training will depend in large measure on the candidate's previous academic experience, on his thesis research, and on his intended occupation after earning the Ph. D. degree. If the student is to derive maximum benefit from his period of formal graduate training, these problems must be handled on an individual basis. The advisor, with the student's record before him and fully cognizant of the student's objectives in pursuing graduate work, should be the one best qualified to develop a custom-tailored, individual, integrated program that will best satisfy the needs of each student.

I should like to make two further points in closing. First, there must be a plan to the selection of elective courses. They must not be chosen haphazardly merely to satisfy unit requirements. They should be as carefully selected by the graduate student and his advisor as are the tiles used by an artist in creating a mosaic. Each should have a purpose and add specifically to the final product.

Second, teachers and courses of study are only part of a graduate student's training. His contacts with other students who have different academic backgrounds can be a significant influence for good in his student and post-student career. We, the teachers and program makers, should not ignore the benefits to be derived for the graduate students (most of whom presumably will come from curricula in colleges of pharmacy) and in the larger sense for the future of pharmacognosy itself by recruiting candidates for the Ph. D.

degree in pharmacognosy from outside the ranks of pharmacy.

We are all familiar with the directions that contemporary research in pharmacognosy may take--biochemical, ecologic, physiologic, agricultural, genetic, etc., and even ethnologic and anthropologic. It is not necessary to enumerate them at length. For qualified students from any of these areas of study, certain exceptions to the general requirements for admission to the graduate program in pharmacognosy should be made. If necessary, important course deficiencies can be made up early in graduate residence. However, discretion should be exercised in the demands made on a student's time in this way. Certainly it should not be mandatory for a student to complete all academic requirements for licensure in pharmacy or for graduation from a college of pharmacy in order to enter graduate studied in pharmacognosy.

The point is that it is important to attract competent individuals with good fundamental training and fresh, new, ideas, even if these individuals do not precisely meet established specific course and minimum unit requirements. This is more important, in my opinion, than completion of a certain prescribed number of units in a certain set of rigidly prescribed courses. The latter policy tends to limit the possibilities for attracting fresh vigor to our field. The former policy facilitates growth of the subject in scope and in stature and offers the best hope for the future of pharmacognosy.

Statistical Evaluation of Experimental Measurements

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Although it is the intent of the investigator to measure a certain value, he actually measures an approximation of that value. Consequently, as a more reliable estimate of the desired value he uses the mean of a series of measurements rather than any single measurement. However, particularly in biological research, the inevitable variation between repeated measurements may be quite large, and the reliability of even this improved estimate is still uncertain. To establish the reliability of measurements in the presence of such variation, statistical analysis is infinitely superior to intuitive evaluation.

The mathematical calculations employed in statistical analyses are fully described in a number of texts and monographs (1-12). Except for slight differences in notation used by the various authors, the methods are highly standardized and the choice between the different sources depends upon individual preference. Space does not permit adequate consideration of the many statistical procedures of value to the pharmacognosist. Discussion will be restricted to comments on some general principles of statistical analysis, on the use of simplified methods of calculation, and on problems in experimental design. Finally, training of the graduate student in the application of statistical methods will be briefly considered.

Reliability of Measured Values. If X is any individual measurement in a series, the mean, $\bar{X}$, can be expressed by $\Sigma X/n$, where ΣX denotes the sum of all measurements and n, the total number of measurements. The deviation of any single measurement from the mean is denoted by $X-\bar{X}$ and the square of this deviation, by $(X-\bar{X})^2$. If the sum of all the squares of the individual deviations from the mean, $\sum(X-\bar{X})^2$, is divided by n, an estimate of the average deviation of a single measurement is obtained. For theoretical reasons which need not be considered here, a more accurate estimate of the average deviation is obtained by dividing the sum of the squares by the number of degrees of freedom, n-1. The value $\Sigma(X-\bar{X})^2/n-1$, called the mean square or variance, is denoted by s^2 or V and has proved the most useful index of variation of a series of measurements. Most statistical methods useful to the biologist employ this index of variation for mathematical evaluation of the reliability of measured values, and many of the other statements of error or variability of measurements are intimately related to this index. For example, standard deviation, denoted by s, the index of variation employed in the t-test for evaluation of the difference between two values, is simply the square root of the variance. Similarly, fiducial limits of a mean, limits within which a specified proportion, usually 95 or 99 per cent, of measurements of the desired value can be expected to occur, are expressed by $(\bar{X}-ts_{\bar{X}})$ and $(\bar{X}+ts_{\bar{X}})$, where $s_{\bar{X}}$ is the standard deviation of the mean rather than of an individual value and the other symbols have the same meaning as before.

However, whatever index of variation is employed, statistical analysis

cannot tell an investigator whether one group of measurements differs significantly from another group or from some theoretical value. Statistical analysis merely indicates the proportion of times that the observed difference could be expected to occur by chance alone, if the measurements were repeated. It remains for the investigator to decide whether his treatment was responsible for the difference in the specific series of measurements.

Value of Biological Assay Technics. Biological assay in its usual form involves the quantitative comparison of the effects of two preparations, one of which is designated the standard. Since the pharmacognosist is very frequently interested in determining the potency of a test preparation, mastery of the methods for statistical analysis of biological assays is essential. In experiments on new drugs for which a standard preparation has not been established, an arbitrary reference standard should be used. While any drug having a similar effect could be used as the standard of reference, it is usually preferable both theoretically and practically to create a standard from a sample of the drug itself. The major criterion for selection of material for a standard is stability; the degree of purity desired will vary according to the specific purpose and conditions of the assay. Since results from different laboratories will be comparable only if they can be referred to the same standard, it is particularly advantageous for all investigators to adopt the same standard of reference even before an official standard has been established.

Mastery of statistical analyses of biological assays is important for another reason. Many types of experiments can be designed as biological assays to permit statistical analysis by the mathematical methods which have been developed for the analysis of assay data. For example, rather than compare a test preparation with a standard of reference, the investigator may choose to compare two test preparations originating from different treatments of the same starting material. In other experiments the test subjects upon which the assay is performed may be subjected to different treatments and then tested with the same test preparation. In all cases statistical analysis of the experimental measurements is the same and familiarity with the mathematical methods for analysis of assay data equips the investigator with technics applicable to many different problems.

Simplified Statistical Analyses. Professional statisticians have developed mathematical methods for statistical analysis which are attractive because they offer greater accuracy from a given number of experimental observations. These methods discourage certain biologists because of their greater complexity. Highly simplified but less precise technics are available which have wide appeal. In practice, it is usually desirable to compromise between precision and simplicity depending upon the specific purposes of the experiment. However, this compromise cannot be made unless the experimenter possesses sufficient understanding of both the simplified and the precise technics to recognize the conditions in which the simplified method should not be employed.

Gaddum recently reviewed the mathematical methods used in biological assays (10) and described thoroughly several very useful simplified methods of statistical calculations (11). Simplification of the calculations is made

possible chiefly by balanced experimental design and by the use of range of variation, the difference between the largest and smallest values in the series of measurements, for estimation of the standard deviation. Balanced experimental design, which in biological assays refers to uniform logarithmic spacing of doses, equal number of observations at each dose level and equal number of dose levels for both the standard and test preparations, will simplify all types of statistical calculations. Slight departure from completely balanced design does not preclude the use of the simplified methods. Range has never been considered a particularly useful index of variation by mathematicians, but its use for estimation of standard deviation for groups of 10 or less values is sufficiently accurate for most purposes. The simplified calculations require less than one-fourth the time needed for the precise calculations.

For statistical evaluation of assays based upon quantal effects, assays in which the proportion of subjects exhibiting an effect of fixed intensity is determined, simplified graphical methods have been widely used in preference to the more precise iterative methods of probit analysis. The results obtained by these simplified calculations are also acceptable for most purposes. However, experience in the graphical fitting of regression lines to experimental data is necessary before the methods can be employed routinely.

Professional statisticians only reluctantly admit that simplified calculations may be useful for most purposes and usually offer lengthy arguments against even their limited use. From a mathematical point of view such arguments are quite sound; from a biological point of view they are less convincing. The biologist who wisely applies simplified calculations within the limits of their design will find such methods quite adequate. The biologist who employs simplified methods unwisely will probably also abuse the most precise methods.

Experimental Design. Statistical analysis of experimental measurements should be recognized as more than a mathematical method applied at the end of an experiment for evaluation of the variation of the measurements. Statistical analysis must also be considered at the beginning of the experiment to provide a basis for proper experimental design. Unfortunately, too few investigators give acequate consideration to statistical analysis during the design of an experiment. Until this is done, the calculation of innumerable standard deviations will merely constitute lip-service to a powerful, though often perplexing, tool. One advantage of proper experimental design, namely, simplification of mathematical analysis, has already been cited. In addition, careful experimental design can often reduce the time and expense necessary to obtain the answer to a specific question.

If a drug causes a graded effect, that is, an effect which varies continuously over a range of values, its potency relative to another drug is usually estimated by determining the doses of the two preparations which produce the same intensity of effect. If the drug causes death or some other effect which is not easily graded, its potency is estimated by determining doses of the two preparations which produce the fixed or quantal effect in the same proportion, usually 50 per cent, of observations. Graded effects and quantal

effects are not independent, and an investigator can frequently design his experiment to employ either type of endpoint for the comparison. Graded effects can always be considered quantal by designating the effect positive when it exceeds some arbitrary value. Conversely, a quantal endpoint can sometimes be replaced by graded effects such as latent period or duration of effect. Other factors being equal, to achieve the same degree of accuracy, an assay based upon a quantal endpoint will require approximately twice as many measurements as an assay based upon a graded effect. Thus, the investigator interested in obtaining the greatest accuracy with a limited number of experimental subjects may prefer an assay based upon graded effects. On the other hand, determination of quantal endpoints is usually more simple than the measurement of graded effects, and an assay based upon quantal effects may offer the advantage of conservation of time. In either case, the investigator should choose the experimental design which most adequately meets his specific needs and purposes.

Another example of the application of statistical analysis to experimental design to increase the efficiency of an experiment might be considered briefly. The confidence limits of a potency estimate by biological assay are modified by factors which can be controlled by the investigator. For example, the confidence limits determined by an assay based upon graded effects will be narrowed by selecting doses of the two preparations which produce approximately equivalent effects, doses of the two preparations which are at the extremes of the linear portion of the log-dose-effect curve, and the minimum number of doses of the two preparations compatible with the other demands of an optimal experimental design and by increasing the number of observations. The confidence limits can also be narrowed by increasing the slope of the log-dose-effect curve and by decreasing the standard deviation of the individual measurements, but these variables are not so readily controlled by the investigator and more usually are characteristic of the assay. The magnitude of the effect of controllable variables on the confidence limits may not always be sufficient to be of practical importance, but the investigator should be aware of the fact that these variables can sometimes be modified to his advantage.

Randomization is the most important characteristic of good experimental design and should be as complete as possible without causing confusion and gross blundering during the experiment. All statistical analyses are based upon the assumption that the measurements were made in a random fashion, and omission of randomization in the design and conduct of an experiment may so invalidate the results that no amount of statistical analysis can correct the error.

Common Sense in Statistical Analysis. Frequently in the application of biostatistics the fact is overlooked that arbitrariness is not completely eliminated from biological research by the use of statistical analysis. Likewise, one often forgets that biological significance does not necessarily parallel statistical significance.

As stated previously, statistical analysis does not furnish an unqualified statement regarding the significance or reliability of a series of experimental measurements. The analysis merely tells the experimenter that the observed

distribution of values could have occurred by chance alone, rather than as a result of the experimental treatment, in a specified proportion of identical experiments. If an observed difference could have occurred by chance alone only once in 1000 experiments, a statement that the difference was caused by the treatment is usually justified. Conversely, if the difference could have occurred by chance alone once in five such experiments, the interpretation that the experimental treatment was without effect is reasonable. Most experimenters feel justified in considering a difference between two values statistically significant if that difference could have occurred by chance alone only five times in 100 similar experiments. Unfortunately, this level of probability, $P = 0.05$, has assumed undeserved importance. Not infrequently, experimenters imply that $P = 0.06$ is markedly different than $P = 0.04$ and even that $P = 0.051$ is different than $P = 0.049$!! In practice, each value of P must be considered as a separate problem. Depending upon the purpose of the analysis, the value of P which can be accepted as indicative of a statistically significant difference may vary from 0.1 to 0.001. In many cases only an accumulation of evidence from several unrelated sources will constitute reliable evidence of the effect of the experimental treatment.

Another example of the necessity for the use of common sense in statistical analysis is shown by consideration of the means 142.6 and 148.9 and their standard errors $\pm$ 0.8 and $\pm$ 0.5, respectively. Application of the simple t-test for the significance of the difference between two means indicates that the observed difference could have occurred by chance alone less than once in 1000 experiments. The experimenter is justified in stating that the difference between these values is statistically significant. However, significance of the difference must be distinguished from magnitude of the difference, and this difference may or may not have biological significance. If these values are plasma sodium concentrations of rats subjected to different treatments, the difference also has biological significance, but if the values represent equieffective doses of two drugs, it is doubtful whether this slight difference in potency merits much emphasis. Thus, in the final analysis, common sense must be superimposed upon every statistical analysis.

Training the Graduate Student in the Application of Statistical Methods. The responsible investigator must possess sufficient understanding of statistical theory and methodology to do more than test the difference between two values for statistical significance. He should be familiar with the various methods of statistical analysis of proved value to the biologist and should be prepared to apply these methods to his own research to best advantage. His training should be adequate to assure efficient use of these methods in experimental design and to permit recognition of the limitations of the methods. Most important, his orientation in the application of statistical methods should be such that he constantly supplements the technics of the mathematical statistician with the judgment of the biological statistician.

One cannot expect every graduate student to achieve optimal proficiency in the use of statistical analysis before his formal training is completed. However, a sound foundation in the application of statistics can be established during the pre-doctorate years. No special prerequisites, in addition to the

usual requirements for admission to the graduate school, are necessary. However, the desirability of adequate mathematical preparation is obvious, and deficiency in such preparation should be corrected as early as possible. The graduate student should receive formal training in statistics early in his program of study and informal training throughout the remainder of his investigative career. Since a student rarely acquires a working knowledge of statistical methodology from a formal course, emphasis should be placed upon informal training. Repeated discussions of experimental design and statistical analysis during the student's research conferences, departmental seminars, journal clubs, and similar sessions should be encouraged. Only by repeated discussions and the actual application of statistical methods to his own research can the student appreciate the value of statistics, learn the means by which he may make use of its benefits, recognize the limitations of available technics, and realize the necessity for supplementing statistical analysis with sound biological judgment.

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Radioactive Tracer Techniques and Their Application In Chemical and Biological Research

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The discovery of natural radioactivity by Roentgen in 1896 may well have as profound an effect upon research in the field of biology and those fields closely associated with it as did the invention of the microscope. This is mainly due to the relatively extreme sensitivity associated with the radioactive tracer method compared to conventional methods now in use.

A simple analytical balance can be read to about .1 of a milligram or 10^{-4} gms. A quartz fibre torsion balance used with very great care and precautions can be used to make measurements to the order of a microgram or 10^{-6} gm. Seaborg, a recent Nobel Prize winner in chemistry, used a quartz fibre balance in his initial study of the atom bomb element, Plutonium, giving great impetus to the field of microchemistry. A still more sensitive instrument is the photographic spectrometer capable of detecting as little as .01 of a microgram or 10^{-8} gms.

Quite in contrast to these approaches is the radioactive tracer method in which one can detect as little as 10^{-19} gms. with relative ease. The expression for the minimum detectable weight is $10^{-23}\ AT_{1/2}$ gms. Where A is the mass member and $T_{1/2}$ is the half-life in seconds of the radioactive element in question. For carbon 11 with a half-life of 20-minutes this minimum weight turns out to be about 1.3×10^{-19} gms.

The following illustration will help emphasize the amazing sensitivity of this method. Assume a pile of silver dollars equal to the national debt of approximately 275 billion dollars. This column of money would have a height twice the distance from the earth to the moon. Further assume that the spectrometer, relatively speaking, is just capable of detecting this amount of money. On the same basis, the tracer method is capable of detecting a single silver dollar. Is it little wonder then, that research in all fields of science has had another gold strike with limits still unknown? Already, the Atomic Energy Commission has authorized over 32,000 shipments of radioactive isotopes to industry and educational institutions for research purposes.

Actually, there are hundreds of radioactive isotopes available for research but much of our interest in tracer techniques revolve around the elements common to the human body. In the order of their weight importance they are: oxygen 65%, carbon 18%, hydrogen 10%, nitrogen 3%, calcium 1.5%, and phosphorus 1%. Most of these elements have useful radioactive isotopes which can be used in studying plant and body processes. The exceptions are oxygen and nitrogen as shown in the following table:

	Isotope	Half-Life	Radiation Characteristics Energy in Mev
+	$_{8}O^{15}$	126 sec.	B+ 1.7
	$_{6}C^{11}$	20.3 min.	B+ .98
	$_{6}C^{14}$	5700 years	B- 0.155; no gamma
+	$_{7}N^{13}$	10 min.	B+ 1.25 and .92
	$_{1}H^{3}$	12 years	B- 0.017-0.018
	$_{20}Ca^{45}$	152 days	B- 0.260; no gamma
	$_{20}Ca^{49}$	2.5 hours	B- 2.3; 0.8 gamma
	$_{15}P^{32}$	14.3 days	B- 1.71; no gamma

+ Not particularly useful biologically because of their short half-lives.

As one examines this table from a biological point of view, three unfortunate features stand out, of which one has already been mentioned. The second is that only calcium 49 emits a gamma ray while the third is the relatively low energy of the beta particles from some of the isotopes. Gamma rays are similar to x-rays and hence can penetrate an appreciable distance through matter whereas these beta particles can be stopped almost completely by the layers of one's skin. These difficulties are largely overcome through the use of proper counting equipment although the very nature of the radiations place severe limitations on the types of experiments possible.

Many illustrations could be given in which the use of radioactive tracers play a very significant role to illustrate the point that hardly a field of science is untouched by this new discovery. Physics, chemistry (particularly organic), chemical engineering, metallurgical engineering, biology and medicine are all fertile fields for the use of the tracer method.

In the field of engineering, for example, one merely need suggest a couple of illustrations. The wear on pistons in a car can now be measured in the matter of minutes rather than days. The piston is made radioactive in an atomic pile and put in place in the engine of a car. Even the smallest amount of wear with its associated radioactivity soon appears in the oil in the crank case. The activity is carefully measured with a geiger counter or scintillation counter and compared to the activity from a known weight of the piston. By simple proportion the weight of metal appearing in the oil can thus be determined.

Oil products from the petroleum industry in Salt Lake City are carried to the Pacific Northwest in a single pipe line. In a very simple way the operator knows just where each product is as it moves along because the products are separated from each other by interfaces of radioactivity which maintain their relative position with respect to adjacent oil products. Banks of geiger tubes located at various designated positions record the passage of the units of radioactivity and hence indicate indirectly the location of the various petroleum products.

In the field of chemistry, it is quite clear that one has a new and powerful tool. With hundreds of radioactive isotopes available the limits of discovery are mainly one's ingenuity in devising new experiments. Consider the case of carbon 14. Since carbon is one of the constituents of a very large number of organic compounds, its radioactive counterpart can be used in these compounds for tracer studies. Composition and decomposition can be studied at will and thus reveal chemical steps that could not be discovered in any other manner. Photosynthesis, complex as this phenomenon is, is slowly yielding its secrets through the use of tracers.

In processes requiring chemical separation of the elements, it is frequently necessary to add a carrier before beginning the analysis. Thus, if iron is the radioactive isotope, stable iron in similar chemical combination is added. In subsequent chemical steps, the stable iron will carry along its radioactive counterpart and so give effective separation to the almost infinitesimal tracer element.

In the field of biology the general procedure involves preparation of a label compound, introduction of the compound into the biological system, and later separation and determination of the labelled element in various biochemical fractions. To insure the above requirements, the following four criteria must be satisfied: (1) The initial activity of the sample must be such that it can withstand the necessary dilution during metabolism; (2) During metabolism, the label must remain with the molecule or portion of the molecule with which it was synthesized; (3) Abnormalities in the metabolic process must not result from the nature of the isotope, and (4) The half-life of the tracer element must be sufficiently long to allow accurate measurements to be made of the radioactivity in the final products. With the larger number and wide variety of tracer elements available, it is not too difficult to meet these requirements in many experiments.

It is now possible to study the rate of uptake of a given element in the leaf or fruit of a plant as a function of soil composition temperature, and time. One can also determine the sections of the stem most important in food transport.

In the animal world one can study such things as constrictions in blood vessels, location of brain tumors, uptake of iodine in the thyroid, synthesis of radioactive (C^{14}) morphine, metabolism of radioactive penicillin, preferential uptake of radioactive isotopes by bacteria, and many, many others. Yet,

this is the beginning and not the end. The years ahead have many surprises in store thanks to the discovery and possibilities of tracer techniques.

EXPLANATION of TERMS

A proton is a unit in the nucleus of an atom carrying a positive electrical charge.

A neutron is quite similar to a proton except that it does not carry an electrical charge.

For a given element, the number of protons in its nucleus is fixed but the number of neutrons may vary (isotopes). For example, hydrogen has three isotopes as follows: ordinary hydrogen with one proton; deuterium with one proton and one neutron; and tritium with one proton and two neutrons.

In natural radioactivity, the atoms are unstable and spontaneously explode into simpler atoms at a rate which determines their half-life.

By half-life is meant the time for the activity a group of radioactive atoms to decrease by a factor of 2.

A negative electron is about $\frac{1}{2000}$ as heavy as a proton and carries a negative charge of electricity. It is associated with the outside structure of an atom. During nuclear explosions, either negative electrons or positive electrons may be created in and hurled from the nucleus.

$_7N^{14}$ $(N_1P)_6$ C^{14} is a terse way of stating that a neutron invades the nucleus of nitrogen, knocks out a proton, and leaves an atom of carbon (transmutation of elements).

Radioactivity can be observed by using ionization chambers, electroscopes, geiger tubes, scintillation counters, etc.

Mev is the abbreviation for a million electron volts and is the energy which an electron acquires on being accelerated through a difference of potential of one million volts.

Methods of Stimulating Students for Graduate Study in Pharmacognosy

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I took the liberty of changing the title of this paper from that listed in the program, because I think this one states more clearly my objective. The other title included, " and Related Biological Areas," and in my case at least, I am interested in Pharmacognosy as the major, thus relegating " other biological areas" to the student' s minor field of study. I will probably trample on some feeling this day, but I assure you that everything I say is meant to be constructive. I accepted this assignment because I love pharmacognosy, and I hoped that I could bring even the mildly interested, yes even the skeptics, to admit that this segment of pharmacy training is potentially tremendous in the contribution it can make to a professional education. At this point I hasten to explain that by the term pharmacognosy in this paper I include by inference not only the subject matter, but the individuals associated with it as well.

It is no illusion that pharmacognosy has elected to rest on its laurels lo these many years. It was sort of a quiet, dignified discipline anyway, so perhaps that was only natural. This complacency was so subtle and insidious that before we realized it, pharmacognosy had been fastened upon by individuals and groups almost onto death. I call this to your attention because it is important to the subject. If we are to stimulate anyone about graduate work in this field we have first to recognize our very obvious faults and correct them. Pharmacognosy itself first needs stimulation, and the related biologists here explain that comes about in at least one of two ways. Depress the inhibitors, or stimulate the augmentors. Why be finicky, let' s use both. But if we are to stimulate anybody, there must first be something to get stimulated about.

Several things are responsible for the flat attitude toward pharmacognosy. These include among the material things the disappearance of crude drugs in that form from the drug stores. I have had druggists and educators too point this out to students of mine as conclusive evidence that we don' t need Nux Vomica anymore now that we have strychnine in tablets, etc. I directed one of the students to just casually ask the man where strychnine comes from. We got the startlingly frank answer, "Merck and Company." Milk comes from " Carnation" cans now days; so we don' t need cows anymore.

This is amusing, but significant news for us. In indignation we might say our brother pharmacists are responsible for this. They had no business taking those active constituents out of drugs, or making those elegant extractive preparations. Then pharmacognosy could have rested secure with rows upon rows of bundled medicinal hay stacked on our shelves in place of the magnificent preparations pharmacy has created from these crude drug sources. Now we all know about this, but the fact that such ideas exist and are communicated rather widely to prospective graduate students makes it difficult to stimulate any great interest in them for the future.

Among the " not so material" things giving pharmacognosy stimulation

a bad time is the " disparaging attitude" taken toward it by many pharmacy educators. A prospective student has a hard time keeping stimulated about pharmacognosy if he hears it slighted by the dean of the institution, or even worse, hears it ridiculed by the instructors in his other courses. I hold this situation primarily against the pharmacognosy instructor, and next against the dean of the institution. The only reason I didn't put the dean first at fault is because I don't think legislating any course's position of significance in the curriculum is the best method of handling it. I would much rather see the pharmacognosy instructor sit down with his colleagues and work out the solution to the problem. May I even mention a couple of approach methods?

I would like to suggest you try approaching the other men with the constructive ideas of " How can I modernize my pharmacognosy courses so that they will correlate better with the fine job you're doing in pharmacy, etc.?" and (2) " Mr. Pharmaceutical Chemist, would you like to do me a favor? We are working with Digitalis in my 143 course and we need additional information about glycosides. How about coming to class with me and giving us 'all' the business on these constituents? Choose your own time." Or (3), " Mr. Pharmacologist, I'll be gone for the next few days, how would you like to discuss the diuretics for my class in pharmacognosy, since this question will come up anyway and I'd like to have you handle it." Or (4), " I'll be talking about the Solonaceous drugs these next few days, why don't you come in and hear what the pharmacognosist thinks of them?"

I have found that most people are rather susceptible to invitations and requests for favors that magnify their significance and the significance of their special field of interest to your own courses. Students likewise are impressed by this apparent cooperative spirit among their faculty, and resistance to learning lessens. However, I still hold the dean responsible for maintaining a reasonable balance of instruction within his institution, and any dean who fails to uphold the tradition and prestige of each segment of his instructional obligation is unworthy of his administrative title. Now, just in case you have lost the idea, I am busy trying to stimulate prospective students in pharmacognosy through the medium of forcefully or otherwise " depressing the inhibitors." Of course if the inhibition is pedagogically intrinsic, corrective surgery may be the same answer. We must of course be mindful too that these same principles of stimulation are likewise to be kept in mind as they relate to the prospective student to be stimulated, except to omit the surgery.

On the positive side of this discussion let's now seek some action by tickling the augmentor factors. That means a quick look at the stimulating mechanism, that's us, as we relate to the organism to be stimulated, that's the prospective graduate student. We have assembled here reputedly the finest pharmacognosy talent in the land. If you were an administrator looking for a stimulator in your organization how many such are there among us, and whom of us would you take? You can't light fires with dead sticks unless you create a spark, or perhaps rub them vigorously enough so the heat of friction causes them to glow once more. Even a bed of coals that once burned brightly but was dampened and left to smoulder and go out can be brought to life again if it is kindled anew. From this seminar I hope will come this new life. Pardon me

for saying so, but pharmacognosists remind me of a nice snug bed of sticks and coals all bedded down with the ashes of tenure and seniority. It's about time we stirred us up to the opportunities that are ours in this fine field of instruction.

To become interested and stimulated about pharmacognosy a prospective graduate student must realize he has a future in it. If we are honest with him we must admit that the opportunities are limited, but by the same token, they are good. Seven requests for pharmacognosists came over my desk this year. A lot more are due to come soon. Because we already don't have enough men, people are being compelled to teach pharmacognosy entirely outside their fields of preparation and training. We must convince prospective students there is a future in pharmacognosy. Research, manufacturing concerns, scientific crime laboratories, and manifold other outlets can use pharmacognosy-trained men. They don't all have to teach for a living, but we need to use our imagination in conceiving new opportunities for these boys.

Pharmacognosy today, like everything else, exists in a changing world. We need to popularize this subject, and instead of just plain facts all the time we need to think more in terms of what, about these drugs, will interest and stimulate students more. We need to consider what knowledge of these drugs is vital, and not mislead ourselves by assuming that everything is, and then grind it in. The trouble with science education is we have too many facts. We spend so much time learning facts we don't have time to think and scheme and dream. For this reason we lack culture.

Pharmacognosy doesn't need to be like that. All the history, glamour, romance and tradition that is pharmacy is ours. The whole world is our garden, and its peoples with their culture and their charms stand by to welcome us. To stimulate, just invite students to visit these strange lands with you, and then let them see it through your eyes and experience. Pharmacognosy to me is a fascinating, cultural, scientific discipline unlike anything else in our curriculum. In this day of conflict and occupation, scarcely a class in pharmacognosy meets that does not have a returned veteran in it who has first hand information of foreign lands. Don't fail to stimulate this augmentor force for your subject.

Participation is an excellent method of stimulation. As questions arise in class, or individually, invite the students to explore them with you and perhaps create a special problem for them. Let this activity be evident with the students making reports to the class. Have them bring in plant specimens too, if they happen to be curious about them. To those who decry this as taking your valuable time, I suggest that it is about time the student's welfare became of paramount interest, and besides, they need some stimulation.

Stimulate interest in pharmacognosy by encouraging good publicity. I personally never miss a chance to talk to student groups, service clubs, garden clubs, and even faculty groups about medicinal plants. I have talked to several scout groups about medicines from natural sources. Fine comments followed these, as a result of which I have been invited to appear on T. V. several times in connection with pharmacognosy. It's something that has to be sold just like

anything else. I find it stimulating.

Pharmacognosy has practical value in the oddest ways, which sometimes can help us to publicize it. Call it showmanship, if you please, and that's alright with me, if it creates interest. I have the State inspectors bringing in suspicious drug samples to me all the time. The students get the case history and then they are invited to participate in the identification. They like it and it's stimulating.

A student brought in a problem one day which, although not strictly pharmaceutical, pharmacognosy still got the credit for its solution. This customer in a store where the boy worked crocheted fine spreads for competitive purposes. Part way through her grandest effort of all, the end popped off the crochet hook. Alas, the change of hooks immediately became evident in the weave of the spread and it appeared that months of careful labor was for naught. She happened to mention it to the student, and in typical, cocky pharmaceutical fashion he requested the broken hook and assured the lady that pharmacists knew everything and could fix it. He then presented the problem to the microscopic pharmacognosy laboratory class and they went to work on it. A detailed drawing of the hook end was made with magnification. The shank, length of the barb, and angle of the barb with the shank were all carefully measured with the occular micrometer. We examined nearly two hundred hooks to get one that matched exactly, and then came the breathless moments of clinical trial. It worked! The spread was completed without a flaw, and pharmacognosy is still getting credit for the job. Those students mention it yet when I see them. That's stimulation.

Have students study labels of preparations. They read like story books. Begin a lecture sometime with, "Class, I'd like to tell you a story about a label I have in my hand." It can include official titles, sources, constituents, doses, uses and all the facts, but it's stimulating to take the dose with a different flavor. Finally, students like to know about special prizes for pharmacognosy, so mention the Kilmer and the Newcomb awards.

In closing these remarks I am mindful that some are probably thinking, "What the hell is he doing to pharmacognosy?" To you all I challenge that I love my subject as much as any, and I'm ready to fight for it. I want to see some fire in your eyes when you speak of it, and I want to see you work and help fit it into the curriculum of your institution where it belongs. If you don't like my ideas about your subject the worst you can say of my pharmacognosy and this paper in the final analysis is, "It may be unclean, but at least it's sterile." To my knowledge no one has ever suffered a pathologic syndrome from it and I hope some one has received some stimulation for the future.

Qualifications for Pharmacognosy Teachers and Teacher-Training Programs in Pharmacognosy

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What qualifications should teachers of pharmacognosy possess, and what educational program will be most likely to result in teachers blessed with these qualifications? These are difficult questions, and before trying to suggest possible answers I would like to rule out of our discussion certain types of qualifications, including some of the most vital characteristics of good teachers.

I refer to such qualities as human kindness and sense of fair play, which are always parts of the stock in trade of any superior teacher. They are not measured by semester hours of graduate credit and I have not the remotest idea what courses to recommend in order to develop them in prospective teachers. I do have an idea that the chromosomes and the environment during adolescence may be as significant in producing such highly desirable human traits as are any courses in the 500 series.

So we pass on to more prosaic but certainly no more important characteristics which we can speak of in terms of credit hours, prerequisites, corequisites, majors, minors and all the other features surrounding certified education. I believe we can profitably divide our discussion into two parts: the qualifications and training of professional pharmacognosists and the same elements for professional teachers.

Being a pharmacognosist by virtue of a process of "laying on of hands", I have tried to get the impressions of experienced and well-trained professional teachers of pharmacognosy through conversation and by reading their published opinions on the education of pharmacognosists. Several teachers have expressed in writing their views on this subject (Youngken (1); Wirth and Voigt (2); Pratt (3)). Each of these pharmacognosists has advocated preparation that is extremely broad and that includes all of the major subsciences of both plant and animal biology.

Youngken (4) has recently written convincingly on the need for strengthening the foreign language requirement for all doctoral candidates.

About ten years ago, Hiner (5), writing on the subject "Recommended Training for a Pharmacognosist," expressed the opinion that the graduate program of an individual student might well include a degree of further specialization within the already specialized area of pharmacognosy. He suggested that the graduate training of pharmacognosists in a restricted field, such as manufacturing, microanalysis, or teaching. Hiner does not question the need for broad training in chemistry, biology and pharmacy.

The concensus of these well-known pharmacognosy teachers and of other prominent men in the same field is to include extensive training in basic and applied plant and animal biology in the graduate program of all

professional pharmacognosists. I doubt if anyone here would take exception to this opinion. I am sure, too, we would agree that modern pharmacognosists must be well-grounded in chemistry, and that the tools and techniques of research must be acquired by those who continue graduate study beyond the level represented by the master's degree.

Does the inclusion of all of these essentials leave any time at all for attention to the special interests referred to previously? In particular, for the graduate student in pharmacognosy who plans to teach is it important to include any special work designed to increase his understanding of the problems he will meet as a teacher and to suggest methods of attacking these problems?

In the course of a discussion on the significance of Graduate Study and Graduate Degrees, presented at the 1950 Teachers' Conference on Graduate Instruction, Dr. Walter C. Russell (6), an outstanding scientist, teacher, and graduate school administrator had this to say:

> As nearly as I can assess the current viewpoint, developed at various conferences and discussions relative to the training of college teachers, faculty members in the subject matter fields desire to have the training of those who elect to teach in colleges and universities left largely in the hands of subject matter departments. There is a feeling that graduate students should not be subjected to formal courses in professional education. For the most part, the attitude seems to be that graduate students should receive any training in the preparation for college teaching on a voluntary basis.

Dr. Russell continues with reference to a prospective college teacher:

> He should also receive some instruction from mature teachers in classroom and laboratory teaching techniques and perhaps with profit some presentation of the principles of learning which one would designate, I suppose, educational psychology. One or more members of the department who are known to be good teachers should have the responsibility of supervising any teaching done by the young graduate student. There is also the question of apprenticeship and if at all possible, the young Ph. D. should be allowed to teach under supervision on an apprenticeship basis, with a salary that would provide a satisfactory living.

It seems to me that Dr. Russell's somewhat mixed feelings on these matters are representative of those of many scientists charged with supervision of the programs of graduate students. The need for knowledge of pedagogical lore and methods is readily acknowledged, but the scientists are not willing to allocate time from the years of graduate study in order to provide for courses in educational philosophy, psychology, or methods.

A generation ago, practically no school of education offered such courses especially designed for college teachers. Within recent years, more has been written and said about the problems of higher education than during any other comparable period of time. Several universities now offer courses designed to help prepare students for teaching in college. And here and there are available

specialized courses devoted to the problems of teaching in a single professional field.

At Michigan, we offer two graduate courses dealing with the current position and problems of pharmaceutical education in the United States. We have labelled these courses Academic Pharmacy, and we believe they represent a minimum of instruction in the field of education for graduate students who plan to teach. Each course is for one semester, three hours per week. This time allotment is certainly not excessive for study of matters which will constitute a major part of the interests of the students for the balance of the professional lives. A brief outline of the content and procedure of these courses will indicate the nature of the instruction that I believe to be helpful to prospective teachers.

1. Educational objectives. These include the objectives of elementary and secondary education, together with brief consideration of their position and their relationships to higher education. Institution-wide, college-wide, and specific course objectives are discussed in some detail. Each student selects a specific course, ordinarily in his field of interest; for example, the general course in pharmacognosy; and his reading and thought are directed toward development of a realistic set of course objectives as he himself conceives them to be.

2. The curriculum. Discussion of this topic is based on The Pharmaceutical Curriculum by Blauch and Webster (7). Problems of sequence and correlation are studied. Based upon his own set of specific course objectives previously developed, each student prepares a syllabus in skeletal form for the specific course he has chosen, and in detail, an outline for one of the topics of his syllabus. Relationships among the undergraduate curriculum, the experience requirements, programs for in-service training of pharmacists, and graduate programs are considered.

3. Measurement of educational achievement. The use of tests and examinations as a means of selecting, motivating, teaching and grading students is studied. Construction and grading of good objective test units, essay-type questions, interpretive test exercises, and performance tests is covered in some detail. Using his own set of specific course objectives and his own syllabus for the course selected, each student devises test units, questions and exercises of the various kinds for the course he proposes to teach. In nearly every case, the objectives and the syllabus require revision when they are critically re-evaluated in the light of the tests and examinations.

4. Methods and techniques. The advantages and limitations of the lecture, the laboratory exercise, the recitation, the demonstration, and the discussion are explored. Demonstration and discussion of role-playing, panel presentation, and the seminar are presented by members of the class. Preparation for, presentation of, and subsequent discussion of various types of audio-visual aids are covered under the topic methods and techniques.

5. Selection and supervision of students. The problem of dignified recruitment of students is considered as well as the various factors involved in selection and admission. Grading practices and promotion policies are discussed. The role of the teacher in guidance and counselling is handled in relation to facilities for these activities of a clinical or highly specialized nature, available to greater or less extent in most of the colleges of pharmacy. The extracurricular program of the college and the non-academic activities of the student are considered as they relate to his growth and development.

6. Responsibilities, supervision, and support of teachers and administrative officers. Here the obligations and privileges of the teacher are discussed, particularly in the light of modern-day inquisitors, the recent presentation by the Association of American Universities, and the official briefs of the American Association of University Professors. Evaluation of teacher performance by colleagues, administrative superiors, and students is presented. Faculty meetings, committee assignments, support for research, departmental administration, and related topics are also covered in some detail.

7. Physical facilities. The various colleges of pharmacy are considered under such designations as overall objectives, type of control, resources of plant equipment, faculties, and general policies. The pharmacy library and its use are also considered under the topic physical facilities.

8. Academic pharmacy in time. The historical development of our system of pharmaceutical education is traced, and the trends in academic pharmacy today are discussed. Finally an attempt is made to picture the colleges of the future. These discussions inevitably involve consideration of the many fields open to the pharmacy graduate and to the man who has completed a program of graduate study, as well as the past, present, and future of the retail practice of pharmacy.

During the year each student makes several presentations in a variety of ways, such as discussion, formal paper, informal talk from notes, panel participation, and extemporaneous talk. He also prepares a number of short essays and each semester a term paper on a subject of his own choosing. A book report is given each term by each student. There are no lectures. Reading assignments are rather heavy, and a substantial majority of the class time is devoted to presentations by the students. These efforts as well as all written work are critically evaluated, including evaluation and constructive criticism of oral work by other members of the class. By the end of the year, the student is fairly well acquainted with much of the literature devoted to pharmaceutical education and related fields in pharmacy, and he has some knowledge of standard references and serials concerned with higher education in general.

The program described here is available in only one institution and that one offers no graduate work in pharmacognosy. So we return to the matter of teacher-training for the prospective teacher of pharmacognosy.

Some of the universities which offer graduate work in pharmacognosy have

schools of education in which one or more professors are devoting at least part of their efforts to helping prepare teachers for college work. Such professors are in a position to advise with an experienced teacher in a college of pharmacy in the development of seminars devoted to the type of program just outlined.

Such seminars are easily organized to provide at one time for the needs of prospective teachers in all the areas of professional instruction. Inexperienced teachers can also profit from participation; in fact, it is not unprofitable for some of us who have been at the game for many years to take part in the programs.

The greatest weakness in the courses we offer in Academic Pharmacy and in seminars on teaching is the absence of supervised practice teaching at the college level. Students who serve as assistants or instructors have at least limited opportunity to put into practice what they are learning. We hope to be able at Michigan to do something along the internship lines suggested by Dr. Russell but this still does not provide supervised teaching experience for the graduate student who lacks the doctor's degree and who is not assisting.

In summary and conclusion, then, I believe that graduate students who plan to teach pharmacognosy must be well-trained in the major areas of plant and animal biology; they should be good general biologists. They should know the rudiments of the major areas of the physical sciences, and be versed beyond the rudiments in organic and biochemistry. Their graduate research should be of such nature that they see at first hand something of what Conant calls the tactics and strategy of science and become at home with the tools of research in their chosen field.

In addition, a moderate amount of attention should be given during graduate study to preparing them to meet successfully the many types of problems faced by the college teacher. To dismiss consideration of preparation for teaching by saying that successful teachers are born rather than made is an unsound evasion of a definite responsibility. No matter how well endowed by nature and nurture in the traits desirable in the teacher, graduate students need guidance and preparation in the art of teaching.

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Physical Requirements for a Modern Pharmacognosy Department

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A college science laboratory traditionally provides space and equipment for one or more laboratory exercises each week and the experiments are conducted in an orderly plan providing each student with identical subject matter. Frequently, also, college laboratory sections are made up of large numbers of students and guidance generally is provided at a student-instructor ratio that does not permit successful instruction or thorough learning. It is also conventional for a student to prepare a written report of his laboratory and library findings. The fashions described above do not provide for different student attitudes, abilities or interests and it has been found that many students can follow directions explicitly and still have little conception of the experiment and its purpose. A written report very frequently represents a compromise between fact and vacuity and only occasionally is complimentary of the instructor's intent.

This introduction ensues experience both as a student and as a teacher. As a result I have lived a laboratory teaching life of unrest and question. Looking back on ten years of teaching pharmacognosy I have never been content with a particular experiment or group of laboratory lessons until there was general approval by students or until the results seemed satisfactory to me. Having worked under diversified conditions I am now surrounded by laboratory equipment and space that offer unparallelled facilities and an even greater opportunity to experiment with experiments.

The general attitude of slavery is all too common among present day students enrolled in required courses. The only solution seems to be in providing a situation of personal responsibility to the laboratory work. For that reason the greater success in my experience has been achieved when a group of experiments are established as required and are followed by elective experiments; elective in the sense that a minimum number of a group are selected by the student and are required for course credit. Student achievement has been found to be greater also when experimental results are reported verbally in addition to a written report. The third feature of experimentation in our laboratory teaching that has paid dividends is the provision of laboratory time outside of assigned periods. This time is a direct challenge to all students in the course to learn more of his required subject and relieves a pressure on those students who normally work slowly.

This general conception of a design of teaching is important in determining the physical requirements and utility of a laboratory in pharmacognosy. The aspect of instructor requirements is also an important consideration in laboratory design. It is desirable to arrange equipment for locker facilities for each student and to plan for laboratory sections of 20-24 students. Although a pharmacognosy laboratory could be shared with some other department, some of the features of the plans, described above, are defeated if such a situation exists.

The integral parts of a pharmacognosy laboratory are: (1) Laboratory desks with equipment drawers, sinks, and gas, electric and water utilities and of a height suitable for both seated and standing operations. (2) Wall cases for herbarium of whole, powdered and mounted drugs. (3) Demonstration table. (4) Hood with steam baths. (5) Microscope wall cases. (6) Notebook case. (7) Table for balances. (8) Tables for ovens, mills, etc. (9) Medicinal plant garden and greenhouse. (10) Stock and Service Room. (11) Facilities for darkening for projection. (12) Library facilities. (13) Wall cabinet for plant principles and proprietaries.

Additional features that should be provided in the building area include a dark-room, a constant temperature room and space for several undergraduate research projects.

The need for each of these facilities can best be explained by the following experiments which are a part of laboratory work in pharmacognosy. The special equipment for each group is listed.

Physical Characterization of Medicinal Plants, Allergens, and Chemical Microscopy

Experiments and instruction in gross morphology and micromorphology and analysis, representing nearly 1/2 of the total laboratory time is best conducted by students when seated at the laboratory table. Microscopes, and the usual related glassware and equipment, microprojection apparatus, hand lenses, ultraviolet lamp, reagents and reagent blocks, polarizing microscope, demonstration eyepieces, projection-drawing equipment, the garden and greenhouse, and dark room facilities are all utilized. The general equipment is student assigned and stored in the desk lockers. The special equipment is maintained as general laboratory equipment for withdrawal from stock when needed. The herbarium material for those whole drugs used in experiments is available in quantity, stored in drawers, and for observation and inspection in jars in laboratory wall cases.

Chemical Characterization of Medicinal Plants

The laboratory work is divided into three general functions: (1) The observation of plant processes relative to drug production. (2)The extraction and isolation of drug principles. (3) Analytical methods.

Experiments with plant processes include the observation of enzymatic reactions describing the processes of the glycosidases, the oxidases, peroxidases, etc., and the lipases. In addition, a fermentation experiment involving the production and isolation of citric acid, penicillin or one of the alcohols is extremely functional. The equipment for such experiments is variable. The general equipment, i.e., beakers and flasks, measuring equipment, test tubes and supports, like the general equipment for use in physical characterization is student assigned. Special apparatus or large or expensive glassware is maintained as stock. Constant temperature facilities and aeration-agitation equipment may be necessary. An autoclave and equipment for sterile filtration is generally required.

Several experiments describing the general procedures of plant extraction and principle isolation are desirable. The experiments must be selected to illustrate principles and techniques and must be of such a nature not to duplicate course material acquired otherwise. These experiments are probably the most demanding in terms of glassware and facilities. It is not desirable to have all students plying identical processes or working with the same plant. Since volatile solvents are frequently used, hood facilities are required. The majority of equipment needs to be checked to the student after selection of the experiment.

Various analytical methods are introduced as experiments or utilized in the experiments described under chemical characterization. The chromatographic techniques using colorimetry as a measure of efficiency and the determination of enzymatic activity or the quantitative evaluation of a fermentation process involves the use of standard analytical procedures.

These experiments, along with demonstrations, dictate the laboratory facilities that are required. It is rare in science teaching to be able to plan a laboratory; however, the opportunity for reconditioning always exists and the equipment and its purposes as I have presented them may be of some assistance to the young instructor who has the opportunity to develop a kingdom of his own. An attached list describes the equipment essential to operations in our laboratory. This list does not include the glassware, used for extraction and fermentation, which is obtainable through a central stock room service.

I have made only mention of facilities for undergraduate research. I would be remiss of an unassigned duty should I fail to mention that in the field of pharmacognosy there are two forces which should more or less stimulate undergraduate research. The long established Kilmer Award and the recent Newcomb Award provide the incentive, at least, for such work. Space facilities for such work is not great but as yet pharmacognosy teachers have sensed little of the opportunity they have to stimulate research in our field. Furthermore I have no statement describing graduate research requirements. These materials are peculiar to the work planned or in progress. I would not attempt, therefore, to describe such a laboratory other than to indicate the desirability of having the undergraduate and graduate laboratories in close proximity along with the stock room and the office of the major instructor.

Pharmacognosy Laboratory Equipment

Furniture

- Laboratory Desks and Stools
- Hood
- Wall Cabinets
- Wall Tables
- Herbarium Case
- Reagent Shelf
- Stock and Service Room Furniture and Shelves
- Notebook Cabinet
- Microscope Cabinets

General Equipment

- Library
- Ovens
- Incubator
- Mills
- Polarizing Microscope
- Microprojector
- Slide Projector
- Screen
- Balances
- Autoclave
- Reagent Blocks
- Hand Lenses
- Demonstration Eyepieces
- Camera Lucida
- Microtones and Equipment
- Sterile Filtration Equipment
- Microscopes and Lamps
- Centrifuge
- Colorimeter
- Chromatographic Tubes
- U-V Lamp
- Ring Stands and other hardware
- Bunsen Burners

Permanent Equipment for Each Student Locker

- Beakers
- Graduated Cylinders
- Funnels
- Evaporating Dishes
- Erlenmeyer Flasks
- Mortar and Pestle
- Slide Box
- Spatula
- Glass Slides
- Cover Slips
- Lens Paper
- Test Tubes and Support

Other Equipment

- Greenhouse and Garden
- Dark Room and Photomicrography Equipment
- Fermentation Equipment
- Extraction Equipment

Section G - SUMMARY and EVALUATION

Summary and Evaluation of the Seminar

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Much could be said by way of summarizing and evaluating the seminar now coming to a close. The limits of time make it necessary to be brief.

The Environment

Before referring to the programs of the seminars I want to comment on two matters. First, I refer to the circumstances of our subsistence while here. The living arrangements made for a fine fellowship. Seldom have I seen a large group that seemed so compatible and happy in their association. The cafeteria arrangement which kept us together during the day was particularly appreciated. It helped to keep the sessions on schedule. The quarters for the meeting were commodious, comfortable, and well organized. We have been well served by the University and those who were responsible for the arrangements. The weather appeared to have been especially tailored for us.

Second, I want to say that our general education has been materially increased and improved by our week in the country of the Utes. Many of us had acquired strange ideas about this land and its people. As a result of our stay here we have had to revise most of our ideas about what John Gunther called "the particularity of Utah among American states." On a number of occasions during the week we have been regaled with the lore of the people, particularly the pioneers; we have looked over the plains, the mountains, and the canyons; and we have noted the remarkable physical and cultural accomplishments of folks who here built beautiful cities and institutions, laid down splendid highways, and made the desert bloom as a rose. We have been profoundly impressed by all these things. The talks we have had from time to time concerning this part of the world, and particularly Dr. Kirkpatrick's interesting and informative address on "Gathering Books and Herbs for the Saints," have been greatly enjoyed and deeply appreciated by all of us. I know of no other place where our general education would have proceeded so rapidly or so extensively as here. One must, of course, except Texas and California; they would have it that way!

So much by way of introduction. Let us look at the seminar.

A Grass-roots Approach

This seminar is in line with a great American tradition. Our plan of government, to a very large extent, leaves educational matters to the

people--to the citizens. Thus, largely through voluntary effort, we work together for our social improvement. Here we are, some 80 of us gathered from 38 states, I believe. And we are very happy to note that four of our Canadian brethren have also joined us in this voluntary endeavor to improve our and their professional service.

Your chairman in his introduction to the seminar aptly referred to this meeting as a venture in self-evaluation. He expressed the hope that from it we would obtain "a clearer concept of the subject and the place it fills in the pharmaceutical curricula," and he thought "that pharmacognosists will emerge from this seminar an inspired and cooperative group of educators." These statements reflect the grass-roots approach to your problem and at the same time suggest the objective of this endeavor.

The Program of the Seminar

In my judgment the program for the seminar was well conceived and outlined. It provided logically for consideration of: (1) the objectives of instruction in pharmacognosy, (2) prerequisite and corequisite courses, (3) teaching methods with special attention to laboratory work and the use of audio-visual aids and laboratory instruments (4) special offerings in the field of pharmacognosy, (5) correlation with other subjects, and (6) graduate instruction.

The papers and discussions presented numerous points of view on the various topics but perhaps not always as clearly and sharply as might have been desired. I fear that at times we have let our spirit of friendliness and good will deter us from speaking out as freely as the occasion warranted. Nevertheless there was spread before us a great wealth of ideas about the matters under consideration. We have been exposed to the thinking of many minds, some of them leading and creative minds.

From the papers and discussions we have come to know one another better in a professional way. Also we have come to a greater understanding of the problems and difficulties which confront those who are devoting themselves to the teaching of pharmacognosy. I am certain that, as a result, we shall see greater professional cooperation among us as we carry on our work during the next few years.

One of the results of this seminar will be a body of good literature on teaching. Many of the papers were good, some were excellent. I am glad to note that they are to be published and thus made available for future use. However, I have one regret. No record was made of the discussions, which means that they are lost except as we individually remember them. I do not think that the cost of verbatim stenographic reports would have been

warranted, but I do wish that there could have been recorded the principal ideas which were brought out by the discussions.

Let us now consider the various main parts of the program.

Objectives of Instruction

Monday was devoted largely to the objectives of instruction. The papers and the discussions revealed the prevailing confusion in the teaching of pharmacognosy. Here, it seems to me, lies your greatest and most immediate problem, which is: How can you, working together, arrive at some rational agreement as to the functions and purposes to be served by your field of instruction? Until you have resolved this problem you will find it difficult to select from the great wealth of available materials of instruction those that should be used. Moreover, until the functions and purposes of the course are clear, you will have difficulty in determining the principles around which the materials can best be organized. Without such principles your courses are likely to be encyclopedic collections or conglomerates of facts and ideas rather than unified courses aimed at accomplishing sound educational objectives.

Relationships of Pharmacognosy

The programs on Tuesday and the first part of Friday forenoon were given to consideration of the relationships of pharmacognosy to other courses. The papers brought out the fact that pharmacognosy is not an isolated subject. Certain prerequisite courses form an essential foundation for understanding the subject, and the course itself provides a fund of knowledge that is essential to later courses. Thus it becomes a link in a well arranged sequence beginning with biology and chemistry and leading up to pharmacology and dispensing. The position of pharmacognosy in the curriculum would then appear to be clear; ideally it should be preceded by courses in biology, microbiology, physiology, organic chemistry, and biochemistry; it should precede pharmacology and dispensing pharmacy. This understanding is, in my opinion, a great gain.

If these conclusions are sound we may see in them certain implications. The course in pharmacognosy may well be the first course in the curriculum that concentrates on drugs as entities. It draws from the physical and biological sciences relevant facts and principles and correlates and applies them to drugs of biological origin in order to gain an understanding of their sources, physical and chemical properties, and the methods by which they are processed for pharmaceutical and medicinal use. This seems to me to be a sound conception of the subject in pharmaceutical education. I would warn you, however, that if you accept it, it will put you on your mettle. Only teachers who are well grounded in the

physical and biological sciences can handle the subject if that conception is to prevail.

Teaching Methods

Teaching methods and procedures received special attention on Wednesday and on Thursday forenoon. A number of you have felt that not enough time was given to teaching procedures; that too much time went into other aspects of pharmaceutical education. I believe there is some justification for that feeling, but I would remind you that the seminar next year is to be devoted entirely to teaching methods.

First, we listened to two papers which dealt with the more general aspects and phases of teaching. Then we heard three papers on orientation of students which suggested how a favorable student attitude can be developed toward pharmacognosy. The proper orientation of students is necessary in all courses of the curriculum, and particularly in pharmacognosy -- a subject whose significance for modern pharmaceutical education is not always apparent to them.

The examples of didactic instruction in the afternoon fell somewhat short of what was apparently expected, largely, I suspect, because not everyone who participated in the program seemed to know just what was desired of him. Nevertheless the papers and discussions showed some striking contrasts and proved quite profitable.

The papers on laboratory instruction reflected various conceptions of the purposes of such work. One of these papers presented a good rationalization of the author's laboratory work. Another paper gave an excellent specific example of how the laboratory work is carried on. These papers suggest several leading questions such as: How much laboratory work is necessary? How does an instructor determine the laboratory exercises to be used? How can the laboratory work be used to stimulate thinking rather than merely memorizing? The pointed paper on physical requirements for a modern pharmacognosy laboratory, through a well stated introduction, indicated the character of laboratory work that is needed today and then outlined the facilities that should be available for such work.

Special Offerings

The scholarly papers on special offerings in the field of pharmacognosy pose a difficult problem: whether such offerings should be taught in separate courses or as topics in a comprehensive course in pharmacognosy. There is considerable objection to organizing new short courses as

new knowledge becomes available; such a process fails to revitalize the established courses with new topics and points of view. In general it would appear advisable, from the point of view of economy in time and learning, to provide comprehensive courses and to incorporate in them from time to time new materials that are pertinent. The study of antibiotics may be a special case as is also the study of pesticides.

Graduate Education

Lastly, we had a fruitful consideration of graduate study of pharmacognosy. Graduate education is of special importance in pharmacognosy because it is the means of preparing teachers. As I see it, you have two great problems. I have referred to one of these, which is to develop a clear understanding as to what functions and purposes your subject shall serve in modern pharmaceutical education. The other of these problems is to prepare enough teachers who are competent to teach the subject in accordance with the views expressed in the seminar. I am under the impression that all too many teachers of pharmacognosy have not had the preparation that would enable them to teach courses in pharmacognosy that are adequate for our times. Coupled with adequate scholarship on the part of a teacher there needs to be a genuine enthusiasm for pharmacognosy. In my opinion, Dean Hiner's emphasis on this point was both appropriate and opportune.

In Conclusion

Such are some of the impressions which the seminar has made upon me. If I have omitted much that was significant to you, I trust you will charge the omission to a lack of time for a longer review and to my lack of technical knowledge of your subject; if I have placed too great value on some aspects of the seminar, you will use your own judgment about them; if I have been overcritical, I hope you will forgive me for it.

I am sure you share with me a feeling of gratitude to those who organized and managed the seminar so well, to the American Foundation for Pharmaceutical Education which supported it, and to the essayists who prepared and presented to us a feast of ideas which we have greatly enjoyed. Let me conclude by saying that, in my judgment, the seminar has been a marked success. We have, I am sure, obtained a clearer concept of pharmacognosy and the place it should have in the pharmaceutical curriculum. And I believe we must agree that it was good for us to have been here.

Some Suggestions Concerning the Teaching of Pharmacognosy

You will remember that on Monday the chairman of the Seminar Committee, Dean Hiner, appointed a committee to prepare and present to the seminar a statement on pharmacognosy. It consisted of Dr. Richard A. Deno, Dr. Willis R. Brewer, and myself. I am asking Dr. Deno to read the statement which we prepared.

Suggestions Concerning the Teaching of Pharmacognosy

Your committee, appointed by the chairman of the Seminar Committee, has considered a number of matters concerning the teaching of pharmacognosy and it now makes the following suggestions:

1. That pharmacognosy be considered as the applied pharmaceutical science which deals with the biological, biochemical, and economic features of natural drugs and their constituents; that the dynamic phases, which are physiological and biochemical in nature, should be emphasized in teaching the subject.

2. That the student of pharmacognosy should have previously had substantial courses in biology (or both botany and zoology) and organic chemistry; that substantial courses in biochemistry and microbiology should be prerequisite or corequisite courses.

3. That the course in pharmacognosy be placed in the curriculum after the basic science courses that are prerequisite to it but before the courses in pharmacology and dispensing; that (a) in the current 4-year curriculum the logical position is in the third year, (b) in a 2-3 plan the preferred position is in the second year of the professional curriculum, (c) in a 1-4 plan the preferred position is in the third year of the professional curriculum, and (d) in a 2-4 plan the logical position is in the second year of the professional curriculum.

4. That, unless required separate courses in such important contemporary subjects as antibiotics, biological products, allergens, and pesticides are offered, introductory discussions of these subjects be included in the general course or courses in pharmacognosy.

5. That the course or courses in pharmacognosy include a substantial amount of laboratory study with exercises designed to illustrate the biochemical and physiological features of drugs as well as such ancillary topics as may be feasible for accomplishing the objectives of the course or courses.

6. That the course or courses in pharmacognosy carry 8 semester or 12 quarter hours of credit, which would usually require 64 or 96 clock hours of didactic instruction and 192 or 96 hours devoted to laboratory exercises and field work.

7. That the Committee on Curriculum of the American Association of Colleges of Pharmacy make a special study of undergraduate instruction in pharmacognosy, perhaps with the assistance of a special sub-committee consisting of teachers of pharmacognosy. Such a study might well run

over a period of several years with occasional progress reports, and it could properly attempt to develop a better understanding of the functions, character, and scope of pharmacognosy as a subject in the undergraduate curriculum than exists at present.

8. That graduate programs for the preparation of teachers of pharmacognosy include substantial and advanced instruction in chemistry, microbiology, physiology, and pharmacology, as well as advanced work in pharmacognosy, and that such programs also provide some instruction and, if possible, practical experience in the teaching of pharmacognosy.

Richard A. Deno
Willis R. Brewer
Lloyd E. Blauch, Chairman

ADDENDA

A Statistical Summary of a Paper Entitled
A Survey of Pharmacognosy

Raymond W. VanderWyk
Massachusetts College of Pharmacy

1. Number of Questionnaires sent out. - - - - - - - - - - - - - - - - - - - 72

2. Number of Questionnaires returned. - - - - - - - - - - - - - - - - - - 67

3. Average number of semester hours credit devoted to pharmacognosy.--6. 8

4. Average number of didactic clock hours devoted to pharmacognosy. --83

5. Average number of laboratory clock hours devoted to pharmacognosy.-80

6. Number of colleges offering elective courses in pharmacognosy. - - - - 31

7. Number of colleges offering graduate work in pharmacognosy. - - - 27

8. Number of colleges maintaining greenhouses or medicinal plant gardens. - 23

9. Number of colleges which include the teaching of microchemical procedures in the pharmacognosy laboratory. - - - - - - - - - - - - - 53

10. Number of colleges which include the study of plant anatomy in the regular pharmacognosy course work. - - - - - - - - - - - - - - - - - - 29

11. Number of colleges which treat plant anatomy separately, either as a special course or in the general botany courses. - - - - - - - - - - 34

12. The following list represents the names of 15 specialized topics which are considered in many pharmacognosy courses. The number after each topic indicates the number of colleges where the topic is considered.

Antibiotics - 50
Insecticides - - - - - - - - - - - - - - - - - - - 41
Vitamins - 38
Allergenic Products - - - - - - - - - - - - - - 32
Herbicides - - - - - - - - - - - - - - - - - - - 32
Fungicides - - - - - - - - - - - - - - - - - - - 31
Rodenticides - - - - - - - - - - - - - - - - - - 31
Vaccines - 31
Allergenic Plants - - - - - - - - - - - - - - 30
Antitoxins - - - - - - - - - - - - - - - - - - - 29
Serums - 29
Economic Products Other Than Drugs - - 24
Prescription Specialties - - - - - - - - - - - 21
Chlorophyll - - - - - - - - - - - - - - - - - - 18
Poisonous Plants - - - - - - - - - - - - - - - 17

13. The identification of crude drugs, powders, and microscopical sections by the student is summarized in the following table:

Table I

	Colleges not requiring identification	Colleges requiring identification	Estimated average number
crude drugs	11	56	118
powders	17	50	38
histological sections	25	42	25

14. Number of colleges not requiring the learning of the definitions of official crude drugs - 13
For those which do the average number of crude drugs is 120.

15. Number of colleges not requiring the learning of doses - - - - - - 23
For those which do the average number of doses is 140.

16. The position of organic chemistry and microbiology in the pharmacy curriculum as related to pharmacognosy is summarized in the following table:

Table II

	Taught prior to Pharmacognosy	Taught concurrent with Pharmacognosy	Taught subsequent to Pharmacognosy
Organic Chemistry	40	22	5
Micro-biology	22	19	23

17. The systems of classification used in teaching pharmacognosy are named in the following list. The number after each name indicates the number of colleges employing that system

Biochemical	26
Taxonomic	11
Therapeutic	8
Physiological	3
Morphological	1
Taxonomic and biochemical	3
Physiological and biochemical	3
Therapeutic and biochemical	2
Morphological and biochemical	2
Physiological and therapeutic	2
Morphological and taxonomic	1

17. (continued)

Physiological, therapeutic, and taxonomic - - - 1
Physiological, biochemical, and taxonomic - - 1
Morphological, biochemica, and therapeutic - - 1

18. Some colleges require courses in addition to the general course in pharmacognosy. Following is a list of such courses together with the number of colleges requiring them.

Vegetable Drug Histology and Microscopy - - - - - - 7
Biological Pharmacognosy - - - - - - - - - - - - - 6
Insecticides, Fungicides, Herbicides, Rodenticides - - 3
Antibiotics - 2
Drug Collection and Medicinal Plant Study - - - - - - - 1
Identification and Medicinal Properties of Vegetable Drugs - 1
Hormones and Glandular Products - - - - - - - - - - - - 1
Serums, Vaccines, Allergens - - - - - - - - - - - - - - 1

19. Some colleges have elective courses in addition to the general course in pharmacognosy. Following is a list of electives together with the number of colleges which offer them.

Histology and Microscopy of Crude Drugs - - - 14
Special Problems in Pharmacognosy - - - - - - - 9
Advanced Pharmacognosy - - - - - - - - - - - - - 8
Insecticides, Herbicides, Pesticides - - - - - - 3
Commercial Pharmacognosy - - - - - - - - - - - 3
Research in Pharmacognosy - - - - - - - - - - - 3
Antibiotics - 3
Seminar in Pharmacognosy - - - - - - - - - - - - 2
Economic Biology - - - - - - - - - - - - - - - - - 2
Field Pharmacognosy - - - - - - - - - - - - - - - 2
Medicinal Plants - - - - - - - - - - - - - - - - - 2
Phytochemistry - - - - - - - - - - - - - - - - - - 2
Advanced Microanalysis - - - - - - - - - - - - - 1
Drug Plant Principles - - - - - - - - - - - - - - 1
Advanced Drug Detection - - - - - - - - - - - - 1
Distribution of Drug Plants - - - - - - - - - - - 1
Animal Health Products - - - - - - - - - - - - - 1
Taxonomy of Medicinal Plants - - - - - - - - - - 1
Hay Fever Pollens - - - - - - - - - - - - - - - - 1
Biological Products - - - - - - - - - - - - - - - 1
Drug Plant Analysis - - - - - - - - - - - - - - - 1
Plant Physiology - - - - - - - - - - - - - - - - - 1
Medicinal Plants of Utah - - - - - - - - - - - - 1
Pharmacognosy Conference - - - - - - - - - - - - 1

20. Some colleges offer graduate courses in pharmacognosy. Following is a list of graduate courses together with the number of colleges which offer them.

Microscopy of Foods and Drugs (Technical Microscopy)	12
Special Problems	11
Advanced Pharmacognosy	10
Plant Chemistry	6
Seminar in Pharmacognosy	5
Microanalytical Pharmacognosy	3
Drug Plant Analysis	3
Taxonomy of Higher Plants	3
Plant Physiology	3
Economic Biology	2
Biologicals	2
Advanced Plant Anatomy	2
Drug Plant Cultivation	2
Drug Plant Principles	1
Advanced Drug Detection	1
Methods in Pharmacognosy	1
Biosynthesis	1
Pharmacognosy Literature	1
Plant Microtechnic	1
Applied Pharmacognosy	1
Microscopical Control Methods	1
Allergenic Plants	1
Economic Pharmacognosy	1
Survey of Official Plant Drugs	1
History of Plant Drugs	1
Commercial Pharmacognosy	1
Antibiotics	1
Quantitative Pharmacognosy	1

21. Summary:

One definite observation can be made from this survey. Pharmacognosy is in a stage of transition. This transition is following those recommendations set forth in the pharmaceutical survey which, in general, de-emphasizes the botanical aspect of pharmacognosy and emphasizes the biochemical phase. Several points can be enumerated to prove this statement.

1. The tendency to teach plant anatomy separately from pharmacognosy, most usually to restrict it to the course in general botany.

2. The relatively large number of schools which do not require the identification of crude drugs, powders, and microscopical sections of crude drugs.

3. The large number of schools teaching microchemical methods of drug detection in the laboratory.

21. Summary: (continued)

4. The large number of schools using the biochemical system of classification.

5. The tendency of many schools to teach microscopy, taxonomy, drug detection methods and specialized aspects in elective and graduate courses.

Practical Aspects of the Teaching of Pharmacognosy

Robert C. Stokes
University of South Carolina

Ladies and gentlemen, have you heard this trite saying: "Pharmacy is the Father of Pharmacognosy, but it is rumored that Pharmacognosy has no Mother?"

This saying vividly illustrates one of the main obstacles that a teacher of Pharmacognosy has to overcome, the dislike or distaste of the students toward this subject. Frequently this antipathy is passed on from one class to another. Consequently, many students, ever before they enroll for the course, have already made up their minds to detest Pharmacognosy.

We, therefore, should ask ourselves why has our science been literally put in the "dog house" in so many colleges of pharmacy? As teachers of this subject we should try honestly and sincerely to find the reason why our course is so disliked by so many students.

There are probably several reasons for this existing condition. First and foremost is the unalterable fact that many of us have failed to alter our teaching methods so that they may be brought up to date and modernized. Too, some of us have failed to make our course in Pharmacognosy as interesting and attractive as it should be.

The purpose of this paper is to present some practical aspects of the teaching of our science. Aspects which, I think, will help to stimulate interest and promote a feeling of good will toward Pharmacognosy.

1. ATTITUDE OF OTHER TEACHERS OF PHARMACY:

Visit almost any School or College of Pharmacy and ask the Professor of Pharmacy confidentially what does he think about Pharmacognosy. From his answer you will probably see that even our own colleagues have a very poor opinion of our science. Is it any wonder, then, that this same feeling permeates to the students themselves?

It seems, therefore, that our first task is to prove to our own faculty members the basic necessity for and the coordination of Pharmacognosy with other subjects. This tie-in of Pharmacognosy can be particularly emphasized with such courses as Dispensing Pharmacy, Pharmaceutical Chemistry and Pharmacology. In faculty meeting, in the office or laboratory, the teacher of Pharmacognosy should be alert, not to defend his subject, but to stress the importance of his course in relation to other courses.

This idea has paid dividends in our own School of Pharmacy. In the discussion of extracts, fluidextracts, tinctures and spirits, the Professor of Pharmacy emphasizes the importance of crude drugs or their derivatives in preparing these galenicals. Likewise the Professor of Pharmacology is pleased to know that many of the drugs he takes up have already been covered

in Pharmacognosy. Consequently, he can devote the greater part of his time to the teaching of Pharmacodynamics.

The same holds true in Pharmaceutical Chemistry. Here the instructor knows that the students have a fundamental knowledge of alkaloids, glycosides, etc., obtained from their course in Pharmacognosy and he can thus outline his work accordingly.

2. SUPPLEMENTARY INFORMATION NOT FOUND IN TEXTBOOKS:

Under this heading I should like to emphasize the importance of reading not only pharmaceutical and allied journals, but ordinary, everyday journals which appear on the newsstands. I have in mind such magazines as Time, Life, Colliers, American, Saturday Evening Post, etc. Frequently these magazines carry interesting, and quite often well-illustrated articles relating to collection or growing of crude drugs, types and uses of various antibiotics, sources and uses of rare or scarce drug products. Even though some of the information in these articles may not be entirely authentic, the interest of the students in these timely subjects more than compensates for this misinformation.

For instance, Collier's recently published an article, illustrated in colors, showing the growing and collection of many drug plants indigenous to Western North Carolina. Time published recently an article on antibiotics with a chart showing the type of antibiotic, diseases for which it is used and its effectiveness. "The Story of Licorice" by MacAndrews and Forbes Company created a lively interest in Glycyrrhiza during our discussion of this drug. "The Star", a publication of the Leprosarium at Carville, Louisiana, changed the discussion of Chaulmoogria Oil in the treatment of Hansen's Disease from an ordinary dull lecture to a fascinating topic about the lives of these unfortunates. Many other similar examples can be cited.

The importance of such articles, I think, is the fact that the student can read and understand them without too much effort on his part and with little or no explanation from the instructor. Along this line, we have at the University of South Carolina, a reading or study room in which organs, pharmaceutical and medical journals are housed, and several newsstand magazines are available at all times for student use.

3. STUDENTS SHOULD BE ENCOURAGED TO BRING TO CLASS ARTICLES AND MATERIALS RELATING TO PHARMACOGNOSY:

In the small town of Orangeburg, South Carolina - some forty miles from Columbia - there are two old physicians who still prescribe many of the old fluidextracts and tinctures. Students from this area bring to class copies of prescriptions from these doctors. Quite naturally, the students feel justly proud in the fact that they are familiar with these so-called obsolete drugs. Once the class gets enthused with the idea of finding supplementary material, the possibilities are almost unlimited. It was truly a revelation to me to see the amount of outside reading that many students do. Every week students bring in or report articles of interest relating to Pharmacognosy. If time permits these are read and discussed.

Along this line, several of my students have become interested in cultivating drug plants for their own satisfaction. Several of them are growing castor oil plants and a few are experimenting with the cultivation of Digitalis.

4. AUDIO-VISUAL AIDS - SUCH AS MOTION PICTURES, SLIDES, ETC.

This factor has been stressed by so many and so often that I will not attempt to discuss it in detail. Unfortunately we do not have enough good motion pictures related to our field. Last year at Philadelphia, mimeograph sheets were passed out listing the motion pictures on Pharmacognosy and related subjects. This list I strongly recommend to any of you who might not have received it.

5. DEMONSTRATION OF PRODUCTS (EITHER ALKALOIDS, GLYCOSIDES, OILS, OFFICIAL PREPARATIONS OR SPECIALTIES) OBTAINED FROM CRUDE DRUGS:

This practical aspect, in my opinion, is one of the most important of all in the teaching of Pharmacognosy. For here the instructor has the opportunity of using the technique of psychology to its fullest extent. He can transform unattractive roots and stems to brightly colored, appealing products with which the students are familiar. The possibilities of this aspect of teaching is limited only by the ingenuity of the instructor.

For example, in the study of expectorants while discussing wild cherry it can be shown that this bark is one of the ingredients of the following specialties: Beechol (Merrell), Cheracol (Upjohn), Cosadein (Parke, Davis and Company), Pine A Col (Smith Dorsey) and Prunicodeine (Lilly). Likewise, White Pine bark is found in the above named products. Sanguinaria is an ingredient of Prunicodeine, Sedatussin and Lobidine. Popular Buds is found in Beechol and Cosadein. Ipecac is found in Lintus Compound, Sed-A-Pine and Sedatussin, Squill in Cosanyl and Cosased. Cocillana Bark is one of the components of Cosanyl, Cosased and Creo-terpin.

While considering the cardiac depressant veratrum viride, the specialties Vertavis and Veratrite should be shown. Of course all of the various antibiotics should be demonstrated while discussing this important group of drugs. Saccharated Pepsin, Essence of Pepsin and Lactated Pepsin Elixir should be shown while discussing Pepsin.

These are just a few examples of the hundreds of specialties which may be effectively used in conjunction with the teaching of Pharmacognosy. Our School of Pharmacy is fortunate in having a Model Drug Store in which we have some five thousand items. These items are attractively displayed according to manufacturer and are available for use by all Pharmacy teachers and by senior students. Such a Model Pharmacy is invaluable as a teaching adjunct and should be a part of every modern School or College of Pharmacy

Not only are specialties valuable in teaching our science, but products

and preparations of crude drugs can be effectively used. Turpentine Spirits and Rectified Turpentine oil can be shown while discussing Terebinthina; Mustard Plaster while studying Sinapis Nigra; Oleomargine and Wesson Oil as products of Linseed Oil; Anethol and Anise Oil as products of Anise; Menthol and Oil and Spirit of Peppermint as products of Mentha Piperita; Castor Oil and Aromatic Castor Oil as products of Ricinus; Paregoric, Morphine and Codeine as products of Opium. Digitora and Digitalis Tincture while discussing Digitalis; and Atropine and Scopolamine while discussing Belladonna and Hyoscyamus.

Here again, the possibilities are almost unlimited. May I emphasize the fact that the demonstration of specialties in the course in Pharmacognosy does not replace the course of New and Non-Official Remedies which follows the Pharmacognosy course.

6. CLEAN, ATTRACTIVE, WELL-ILLUMINATED, CHEERFUL LABORATORY WITH AMPLE CHARTS, PICTURES AND DISPLAYS

Next to Chemistry the Pharmacognosy laboratories in many schools are the most drab, dingy and unappealing rooms of any in the school. Dirty walls and old equipment along with a few old specimens of crude drugs complete the dismal picture. We have failed in most cases to keep pace with department stores, grocery stores, etc., in modernizing our classrooms and laboratories.

I realize, of course, that the lack of funds is responsible to some extent for some unattractive quarters. Few, if any, of us have unlimited funds to spend for equipment and supplies. Yet I do feel that all of us with a little ingenuity, could materially improve the general appearance of the Pharmacognosy Laboratory. Here are a few suggestions with which to start:

a. Have the room scrubbed and cleaned thoroughly.
b. If possible, get walls and desks repainted.
c. If lights are insufficient, try to obtain new light fixtures; otherwise use bulbs of higher wattage.
d. Hang several framed pictures of botanical nature on the walls.
e. Use maps, charts and displays to full advantage.
f. Keep the laboratory clean and attractive.

At my institution the School of Pharmacy has recently moved into new quarters. Consequently, our Pharmacognosy Laboratory is well-lighted with new modern fixtures and equipment. In addition, we have hung framed pictures of Digitalis and several paintings of the Parke, Davis series. Display cases with sliding glass doors contain crude drugs in attractive bottles along with attractive arrangements of volatile oils and glandular products.

The students have used this new laboratory for one year now. But the increase in morale among the students is truly astounding. They are proud of their new quarters and especially of their new Pharmacognosy Laboratory.

In conclusion, may I say that in my honest opinion if we teachers of

Pharmacognosy will conscientiously carry out these practical aspects we can prove conclusively to both students and our colleagues that Pharmacognosy is not an obsolete and decadent science, but rather a fundamental and vital part of Pharmacy.

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